Aleutians East
Coastal Resource Service Area
Coastal Management Plan

— VOLUME III —

An Analysis of Potential Development and Environmental Sensitivity in the Aleutians East Coastal Resource Service Area

July 1985

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Produced under the direction of the Aleutians East CRSA Board.

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ALASKA COASTAL MANAGEMENT PROGRAM

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TABLE OF CONTENTS

Section	Title	Page
	TABLE OF CONTENTS	i
	LIST OF FIGURES	iii
	INTRODUCTION	1
1.0	GENERALIZED DEVELOPMENT ACTIVITIES, IMPACTS, AND SENSITIVE RESOURCES	3
1.1	DEVELOPMENT DESCRIPTIONS	5
	1.1.1 OUTER CONTINENTAL SHELF OIL AND GAS	5
	1.1.2 SUBMERGED LANDS, TIDELANDS, AND ONSHORE OIL AND GAS DEVELOPMENT	9
	1.1.2.1 Submerged Land and Tideland Oil and Gas Exploration, Development, and Production	9
	1.1.2.2 Upland Oil and Gas Exploration, and Production	10
	1.1.3 MINERALS MINING	11
	1.1.3.1 Lode Mining	13
	1.1.3.2 Placer Mining	14
	1.1.3.3 Offshore Mining	15
	1.1.3.4 Sand, Gravel, and Rock Mining	17
	1.1.4 MARINE TRANSPORTATION	18
	1.1.4.1 Pipelines	18
	1.1.4.2 Shipping	19
	1.1.4.3 Ports and Harbors	19
	1.1.5 TRANSPORTATION AND UTILITY CORRIDORS	21
	1.1.6 ALTERNATE ENERGY SOURCES	24
	1.1.6.1 Wind Energy	24
	1.1.6.2 Geothermal Energy	25
	1.1.6.3 Hydroelectric Development	25
	1.1.7 COMMERCIAL FISHERIES DEVELOPMENT	27
	1.1.8 RECREATION AND TOURISM	28
	1.1.9 SPORTFISHING AND HUNTING	29
	1.1.10 LAND DISPOSAL	30
1.2	IMPACT IDENTIFICATION	31
1.3	IMPACT DESCRIPTIONS	33
	1.3.1 DISTURBANCE OF FISH POPULATIONS	33
	1.3.1.1 Movement Blockage	33
	1.3.1.2 Blasting	35
	1.3.1.3 Seismic Testing	38
	1.3.2 DISTURBANCE OF WILDLIFE POPULATIONS	39
	1.3.2.1 Activity	39
	1.3.2.2 Noise	42
	1.3.2.3 Migration Impediments	46

Section	Title		Page
	1.3.3	MARINE AND AQUATIC HABITAT ALTERATION	48
		1.3.3.1 Dreding and Filling	48
		1.3.3.2 Shoreline Modification	50
		1.3.3.3 Flooding and Dewatering	52
		1.3.3.4 Sedimentation	54
		1.3.3.5 Stream Channel Alterations	55
	1.3.4	TERRESTRIAL HABITAT ALTERATION	57
		1.3.4.1 Loss of Terrestrial Habitat	57
		1.3.4.2 Erosion	59
	1.3.5	WATER POLLUTION	60
		1.3.5.1 Oil Pollution	60
		1.3.5.2 Siltation	65
		1.3.5.3 Sewage	67
		1.3.5.4 Seafood Processing Wastes	68
		1.3.5.5 Heavy Metals/Toxic Substances	70
	1.3.6	AIR POLLUTION	73
	1.3.7	HUMAN/ANIMAL INTERACTIONS	75
	1.3.8	CULTURAL IMPACTS	77
	1.3.9	IMPACTS ON COMMUNITY INFRASTRUCTURE	78
	1.3.10	VISUAL AND AESTHETIC IMPACTS	79
	1.3.11	DISTURBANCE OF HISTORICAL AND ARCHEOLOGICAL SITES	80
	1.3.12	DISRUPTION OF COMMERCIAL FISHING ACTIVITIES .	81
		1.3.12.1 Pre-emption of Fishing Grounds	81
		1.3.12.2 Gear Loss or Damage	82
		1.3.12.3 Tainting	84
1.4	ADDITIONAL INFORMATION ON IMPACTS		85
2.0	POTENTIAL DEVELOPMENTS IN THE ALEUTIANS EAST CRSA.		87
2.1	POTENTIAL DEVELOPMENTS AND SENSITIVE RESOURCES		89
	2.1.1	OUTER CONTINENTAL SHELF OIL AND GAS	89
	2.1.2	STATE SUBMERGED LANDS, TIDELANDS, AND AND ONSHORE OIL AND GAS DEVELOPMENT	98
	2.1.3	MINING	99
	2.1.4	MARINE TRANSPORTATION	101
		2.1.4.1 Pipelines	101
		2.1.4.2 Shipping	102
		2.1.4.3 Ports and Harbors	103
	2.1.5	ONSHORE TRANSPORTATION	105
	2.1.6	ALTERATIVE ENERGY	106
	2.1.7	COMMERCIAL FISHERIES DEVELOPMENT	107
	2.1.8	RECREATION AND TOURISM	113
	2.1.9	SPORT FISHING AND HUNTING	113
	2.1.10	LAND DISPOSAL	114
3.0	REFERENCES		115

LIST OF FIGURES

	Title	Page
Exhibit I	Potential Impacts to Resources from Coastal Activities	32
Figure 1	Potential Developments in the Aleutians East CRSA	90
Figure 2	Proposed Federal Oil and Gas Lease Sale Schedule and Areas ...	91
Figure 3	Resources Sensitive to Oil Spills Resulting From Bering Sea OCS Oil and Gas Exploration and Development	96
Figure 4	Balboa Bay - Port Moller Transportation Corridor and Apollo Mine	100

LIST OF TABLES

Table 1	OCS Exploration and Production Time Table	6

INTRODUCTION

The Aleutians East Coastal Resource Service Area (CRSA) is faced with the possibility of a variety of new developments. Much of the potential development is, however, speculative, as there are few specific major development projects currently underway or in the final planning stages. Without project descriptions, locations, and timing, specific impacts to resources cannot be determined. The purpose of this Analysis is to provide the Aleutians East CRSA with a tool for evaluating proposed developments. It is intended to identify issues and concerns for the coastal planner to investigate; it does not present the policies for oversight of development activities in the Aleutians East CRSA. It is also recognized that many of these development activities may be regulated by existing state and federal programs.

Section 1.0 of the Analysis provides generalized descriptions of development activities and resulting environmental impacts that could occur in the Aleutians East CRSA. Section 1.1 gives the reader an overview of the types of development that may occur in or affect the Aleutians East CRSA. Section 1.2 identifies possible impacts of each type of development through use of a matrix. Section 1.3 briefly describes each category of impact, identifies environments and populations sensitive to that impact, and lists general methods that can be used for minimizing the impact. It must be emphasized that the suggestions provided for minimizing impacts are only general guidelines. Specific mitigation measures cannot be established until the details of a project are known. A guide to reference materials that include more detailed information about reducing the impacts of certain types of development activities is found in Section 1.4.

In Section 2.0 of the Analysis, development scenarios specific to the Aleutians East CRSA are summarized, and where sufficient information is available, locations and resources sensitive to potential impacts from the development are identified. Information concerning sensitive resources is taken from Volume II, the Resource Inventory for the Aleutians East Coastal Resource Service Area;

the reader is referred to that document for additional information. The analyses are general in nature and intended to highlight significant or sensitive resources. They do not replace the need for project specific impact analyses after the precise plans for development are known.

SECTION 1.0: GENERALIZED DEVELOPMENT ACTIVITIES, IMPACTS, AND SENSITIVE RESOURCES.

1.1 DEVELOPMENT DESCRIPTIONS

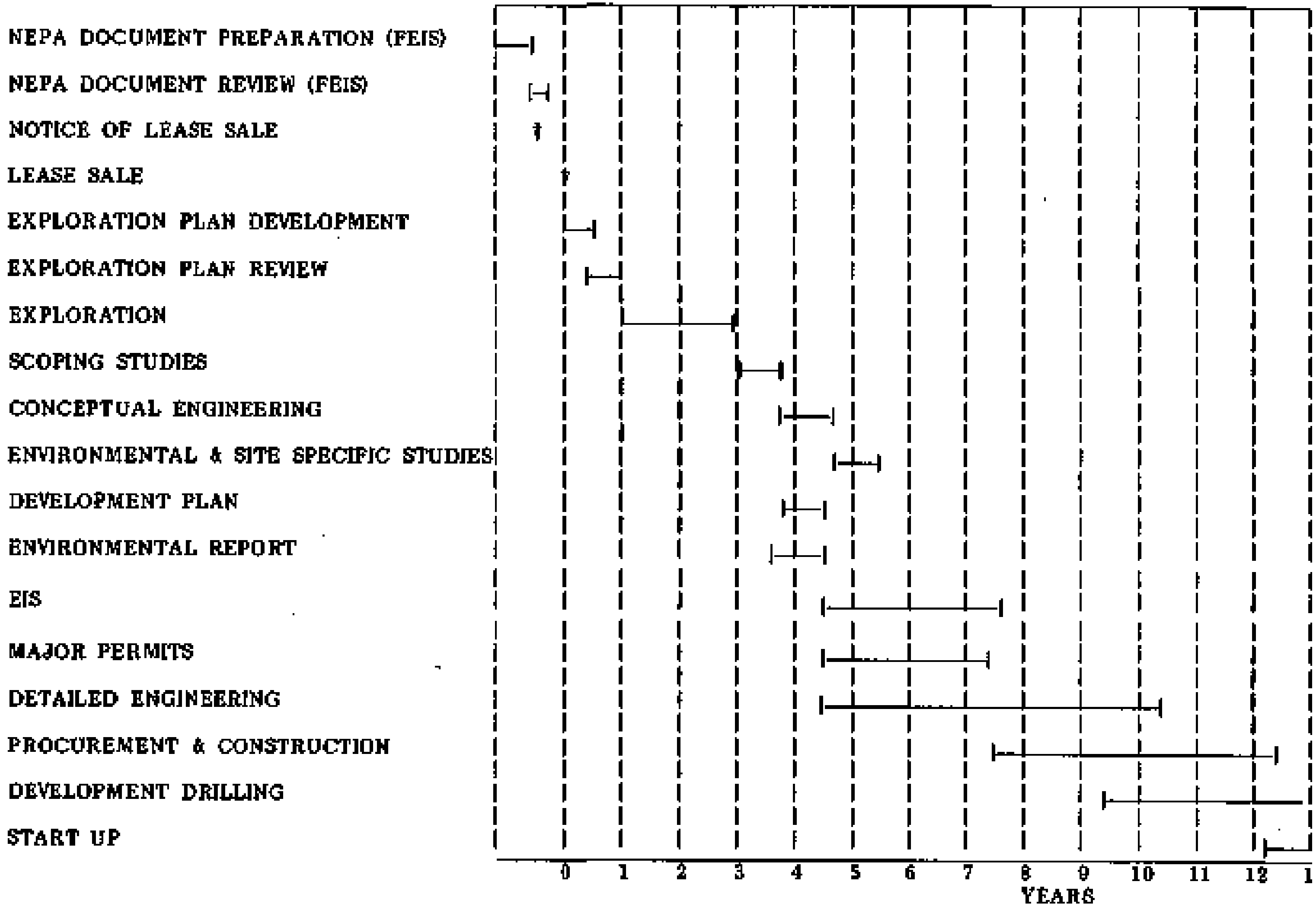
1.1.1 OUTER CONTINENTAL SHELF OIL AND GAS

The exploration and development of Outer Continental Shelf (OCS) oil and gas resources is a multi-year process that consists of exploration, development, and production phases. The general timing of major exploration and production events is shown in Table 1. Each phase has distinct offshore operations, structures, personnel requirements, and onshore support needs. It should be emphasized that in all frontier areas there is absolutely no guarantee that commercial quantities of oil or gas will be found. If they are not, activities will not proceed past the exploration phase.

Exploration

Prior to a lease sale, some exploration activities take place. These activities are primarily geophysical surveys to locate geological formations that have some probability of containing oil or gas. Offshore geophysical surveys (commonly called seismic surveys) are conducted from 150 to 200-foot specially equipped vessels. Survey vessels tow two cables from their stern — a recording or streamer cable at 20 to 40 foot depths that is typically 2 miles long, and a sound source (typically an airgun array, although in some cases explosives are used) at a depth of about 20 feet. During survey operations, the maneuverability of the slow-moving vessels is severely limited. Seismic surveys are usually conducted on a grid system over a specific area of interest, so it is necessary for the vessel to stay on its planned track line. The duration of seismic surveys is on the order of a few months and may cover areas ranging from 10 to 100 square kilometers. Prior to a lease sale, Continental Offshore Stratigraphic Test (COST) wells are often drilled as a result of geophysical surveys to assess the resource potential of the mapped geological formations. COST wells are similar to exploration wells except that they are not aimed at finding oil but rather are used to obtain sediment cores to refine geophysical work (Starr et al. 1981).

TABLE 1. OCS EXPLORATION AND PRODUCTION TIME TABLE



After a lease sale, preparations for exploration activities begin. An exploration plan is prepared, required permits are obtained, and equipment is procured. These activities often require a year or more to complete; hence exploratory drilling usually does not begin until a year after a lease sale has occurred. Exploratory wells are drilled to determine if oil and gas are present. Exploratory drilling may be conducted from a jackup rig, a drill ship, or a semi-submersible rig; the choice of equipment is influenced by water depth, wind, and sea and ice conditions, target depth to be drilled, and sometimes competition for available rigs. Exploratory drilling may last from several months to several years. During the drilling several events occur. Vessel and aircraft traffic increases around the drilling structure as personnel and supplies are shuttled to and from the drill rig. While drilling a well, drilling muds (special mixtures of clay, water or oil, and chemicals) and drill cuttings may be discharged into the marine environment (see Section 1.3.5.5). Drilling muds are often recirculated during drilling but may be discharged into the marine environment during the drilling operation, after the casings of wells have been set, or as the wells are completed. The quantity of the discharge is related to the depth and diameter of the hole being drilled.

Temporary onshore service bases are needed to support offshore exploratory drilling operations. These bases are used to transfer materials between land and the offshore drilling rigs. Supply vessels and helicopters are used to shuttle personnel, equipment, and supplies; hence bases must have harbors, dock space, air strips, helipads, warehouses, open storage space, and quarters for supervisory and communications personnel. Existing facilities are usually used if available; if necessary, new facilities are built.

If sufficient quantities of oil or gas are discovered during the exploration phase, additional wells are drilled to determine the size and extent of the find. These wells are similar to exploration wells. Production plans are then made, permits are applied for, and field design is started. Decisions regarding platform location, method for transporting the crude oil, and the location of permanent support bases are all made at this time. These preparations for development occur over a period of several years.

Development/Production

The development phase is the period of greatest onshore and offshore activity. Construction of required facilities takes place over a five to six year period. Onshore, a variety of facilities such as permanent service bases, oil terminals, and port facilities are built. Permanent service bases are similar to and provide the same service as temporary service bases but are larger. Oil terminals are used to store crude oil from offshore production platforms for transfer to tankers. They may be located on- or offshore, although onshore facilities are more common. Some processing of the crude oil may occur at the marine terminal to separate it from its impurities, although it is more likely that water and gas would be separated from the crude oil on the production platform then re-injected into the formation (AOGA 1984). Stationary offshore production platforms which remain in place for the life of the field are installed and development drilling takes place. The number and placement of production wells depends on the extent and physical attributes of the field. Thirty or more wells may be drilled from a typical platform. If a pipeline is to be used for transporting the crude oil to onshore storage facilities, it is constructed at this time. Pipelines and marine terminals are discussed in Section 1.1.4.

The production phase is a period of sustained low-level activity from installed facilities. It may last from several years to several decades depending on the size of the reservoir and the rate at which oil is extracted. At the time it becomes uneconomical to continue production operations, most oil field structures are dismantled, shut down, or converted to other uses. Government regulations require that offshore structures be cut off below the mud line and entirely removed. Pipelines are usually left in place because of the high cost of removal. Wells are cemented in and the sea bottom well site is dragged to remove obstructions. Onshore facilities are either closed down or converted to another use.

1.1.2 SUBMERGED LANDS, TIDELANDS, AND ONSHORE OIL AND GAS DEVELOPMENT

This section addresses all non-OCS oil and gas developments and includes uplands, tidelands, and submerged lands. Petroleum development within the coastal three-mile limit is regulated by the State of Alaska including activities in coastal tidelands.

1.1.2.1 Submerged Land and Tideland Oil and Gas Exploration, Development, and Production.

Shallow water and tideland oil and gas exploration is similar to OCS oil and gas exploration and development except that seismic survey techniques sometimes must be modified and opportunities may exist for the use of man-made gravel islands for exploration and production drilling in shallow coastal waters of submerged lands and tidelands. Artificial islands are bottom-founded structures built from marine or onshore unconsolidated gravel deposits. In the past, most artificial gravel islands have been used as platforms to drill a single well, but several wells may be drilled. The technology of gravel island construction in recent years has been toward design and construction of islands which can be located in deeper water, resist environmental forces of greater magnitude, make the volume of dredged material less dependent on water depth, and permit a portion of the island to be reused (Roberts and Tremont 1982). Artificial islands constructed elsewhere in Alaska (Beaufort Sea) have been built in waters from 3 to 39 feet in depth.

Artificial island construction techniques include hydraulic placement of fill material by suction dredge, or hydraulic or mechanical placement of fill material inside retaining walls. Equipment used to construct the islands could include barges, clamshell excavators, hoppers, cutter suction dredges, dump trucks, front-end loaders, and caterpillars (Roberts and Tremont 1982).

1.1.2.2 <u>Upland Oil and Gas Exploration, Development, and Production</u>

Development of upland oil and gas resources begins with geological reconnaissance and mapping of the area. This is accomplished with field crews who explore the area on foot and from the air, taking photographs and making observations. No heavy equipment or extensive facilities are needed for this phase. Little, if any, surface disturbance results from these activities.

The next phase of exploration involves seismic surveys to help outline the potential field. The energy source for upland seismic survey may be small dynamite charges that are exploded below ground, compressed air, or vibrators. In areas of dense vegetation, straight line paths are usually cleared to allow access by seismic crews. Tracked vehicles and small drill rigs (used to drill blast holes) are used during seismic surveys.

The final phase of exploration includes the drilling of exploratory wells. This requires the construction of roads, drill pads, and, in many cases, airstrips, docks, and/or camps to bring in heavy equipment and house drill crews. These facilities must be temporary as the State does not allow the construction of permanent facilities in support of exploratory activities. If an oil or gas discovery is made, additional wells may be required to define the field. Often exploratory drilling continues concurrently with construction of facilities and roads for use during the production phase of development.

If a discovery will yield economical amounts of oil and/or gas, the project moves into the development and production phase. Road systems, camps, and dock facilities are expanded to accommodate the increases in manpower and material needed at the site.

If the field is in an area remote from existing communities, full camp facilities must be provided for the workers. This is also the case if the work site is near a town or village which cannot meet the housing needs of the work crew. Camps must be built in locations which are 1) easily accessible by road, air, or sea; 2) near a source of fresh water; 3) near a source of gravel; and 4) suitable for construction of sewage treatment, solid waste disposal, and fuel storage facilities. Camp construction begins with clearing vegetation from the site and leveling or filling as needed. Dormitory type structures are usually built as living quarters. Offices, cafeterias and kitchens, warehouses and maintenance shops are also needed. Often these are portable units which can be dismantled or moved when there is no further need for the camp. Water must be available for camp use. This can be pumped from lakes or streams or from a specially dug well and treated prior to use. Sewage treatment plants and lagoons are also needed. If no other power source is available, electrical generators are used. Tanks to store deisel, gasoline, and fuel oil must also be built.

Oil and gas development requires drilling production wells. The distribution and number of production wells depends on the depth and characteristics of the oil and/or gas reservoir. Production wells are similar to exploratory wells. A storage and/or transportation system is also needed for the petroleum product obtained. Both oil and gas may be transported by pipelines or by ocean tankers. Transport of natural gas by tanker requires the construction of a gas liquification facility or LNG plant where the gas is compressed, cooled, and stored as a liquid in cryogenic tanks. LNG facilities require large amounts of water for cooling and the proximity of port facilities. Ocean-going tankers require deep water ports and specially built harbor and loading facilities.

1.1.3 MINERALS MINING

Mining activities for the development of mineral deposits depend on the target mineral and the type and location of the deposit. Minerals may occur in upland areas as lode deposits (metallic ores or minerals in defined veins or consolidated with other rock within definable limits) or placer deposits (associated with minerals segregated and/or concentrated by rivers and streams). Coal deposits often occur in identifiable seams or beds, but are not considered a "lode" mineral. Mineral deposits may also be present in sea bottom materials of offshore areas, or in beach or tideland sediments where they have become sorted and/or concentrated by wave or tidal action. Deposits of accessible gravel and rock may become important resources for the construction and development of projects such as roads, building site pads, processing facilities, ports, causeways, breakwaters, jetties, and possibly gravel islands in shallow offshore waters.

The first step in developing any mine is exploration and confirmation of the presence of a mineral deposit. The determination of economic viability of mineral development is dependent on the unit value of the mineral, the location, extent, and grade of the deposit, access to the potential mining site, the amount of overburden or depth to the mineral deposit, processing requirements, and transportation of the extracted product to markets. In remote locations, the limited availability of established transportation systems and port facilities is an important factor in consideration of economic viability of mining activities. The Aleutians East CRSA has the advantage of proximity to deep water areas which could be developed as ports.

Exploration

To confirm the presence of minerals and define the extent of the mineral deposit, exploration activities are necessary. The general approach to mineral exploration is the same for hardrock deposits, placer deposits, coal, or offshore deposits. As an initial step, exploration involves a thorough evaluation of the known geology, including the presence of recognized mineral terranes. Preliminary reconnaissance by foot, boat, light plane, or helicopter may occur to establish presence of mineral deposits and collect samples for additional testing. Large geographic areas are usually explored, but statistically only a very small percentage of the land surface within a mineralized province will overlie mineral deposits that can be economically extracted. Depending on the mineral, type of deposit, and location, exploration could include excavation of test pits or drilling with wheeled or tracked equipment to obtain samples or cores for further analysis. Conventional rotary drills or reverse circulation drills are used to explore limited areas. Exploration of submerged lands is conducted by core and rotary drilling from either a boat or barge. Drill holes may enter bedrock since most valuable placer deposits lie at the point of contact between the overburden and bedrock.

Development

Once the presence of a mineral deposit has been established, exploration activities continue to establish the grade of the material and its areal extent (the size of the reserve). Systematic sampling on a closely-spaced grid system may occur at this time. Additional geologic determinations might include magnetometer surveys and seismic work for outlining placer deposits in offshore sediments. Following discovery and confirmation of a mineral deposit, development activities may occur as economics of the situation dictate.

1.1.3.1 Lode Mining

Where a mineral deposit is present in a defined vein or as a component of a host rock, hardrock mining may be required to extract the mineral either as a processed product (most common for precious metals such as gold) or as an ore to be transported to another location for final processing and extraction. Hardrock mining may occur as an open-pit operation when the mineral is close to the surface (commonly used for copper and coal deposits) or as a mine shaft drilled to areas of mineral occurrence. However, neither open pit mining nor underground mining are used exclusively for extraction of a particular mineral.

Open pit mining requires large equipment to construct off-loading facilities, roads, airstrips, personnel support structures, and stockpile and harbor facilities. An open pit mine could require the removal of significant quantities of overburden (non-mineral surface materials) to gain access to the mineral deposit. Depending on the depth of the deposit and the size of the mining operation, disposal of this overburden could constitute a major activity associated with the mining projects. To date, large-scale restoration and rehabilitation of surface mined areas has not been attempted in the Aleutians East CRSA.

If the target mineral is an ore which requires initial processing to remove impurities or concentrate the mineral prior to shipment, processing facilities could be constructed at or near the site of extraction or shipment. Processing procedures usually require a dependable water supply, a source of electrical power, and extensive stockpile areas for processed ore and processing wastes. Economically viable open pit mining operations in remote areas must usually be on a large scale and continue over a number of years to justify the investment in facilities and equipment.

Mine shafts with tunnels at levels of mineral occurrence could be constructed where the removal of extensive overburden is difficult or cost-prohibitive. Although below-ground mining may require less heavy equipment and surface disturbance, the access, support, processing, and shipping facilities can be as extensive as those required for open-pit mining. This type of mining activity is most prevalent where precious metals such as gold are being extracted. The cost of handling and processing large quantities of low-grade and/or low-value ore often precludes below ground mining in areas that lack an established transportation system and support infrastructure.

The processing of ore at the mine site can include the use of chemicals in the extraction process. Processed materials may also contain some toxic substances such as arsenic and mercury which can potentially be leached from the ore stockpiles or processed material disposal areas. Disposal of extensive quantities of processed materials may be necessary at the mining site or in the vicinity of the processing facility.

1.1.3.2 Placer Mining

Where minerals are present as a result of waterborne or glacial deposition, placer mining operations may be used to extract the target minerals from the accompanying unconsolidated materials. Following exploration and confirmation of a mineral deposit, a placer mining operation can involve the construction of access roads, airstrips, clearing of vegetation and overburden with heavy equipment, construction of stream diversions and settling ponds, and construction of a processing facility. Once the mineral-bearing material is located, placer operations generally involve the separation of coarse and fine materials or components of differing densities through the use of a washing operation. This requires the availability of a dependable water source close to the placer operation or establishment of a water supply through the use of dams, pipelines, or diversion projects. The discharge from the washing operation which contains suspended fine materials is discharged to settling ponds or directly back to the adjacent waterbody. When a placer mining operation is situated in a narrow valley or is constrained by topography, a lack of available space may preclude the construction of settling ponds. Where available water resources are limited, recycling of process water may be necessary to support the mining operation.

Water-dependent placer mines may curtail operations during the winter if freezing temperatures interfere with washing operations. Some types of mineral extraction processes may include the use of chemicals to facilitate mineral recovery; cyanide compounds are often used in this procedure. Due to the necessity to expose or uncover mineral deposits, placer operations can potentially disturb extensive areas of river valleys and benches adjacent to watercourses. The processed materials remaining after the washing operation are generally the coarser components of the original material since the finer particles have been removed.

Support facilities for placer operations usually are not extensive since a large labor force is not required. Equipment maintenance and storage facilities, fuel storage facilities, and living quarters are the principal support facilities. Since gold is the primary objective of most placer activities, there is usually no need to establish an extensive transportation system for product delivery.

1.1.3.3 Offshore Mining

Dredging is a method of mining mineral resources by scraping and removal of solids from the sea floor or streambed. Floating dredge operations for mining can occur in rivers where placer deposits are present or in the tidelands and offshore submerged lands. Following discovery and confirmation of a mineral deposit, a wide variety of dredge equipment and procedures can be used to extract minerals. The most common methods of recovery in dredging operations include draglines, clamshell scoops, bucket dredges, or hydraulic dredges. In offshore areas, hydraulic dredges (those which pump a water/sediment mixture) can include equipment with cutter heads, suction dredges, and airlift dredges (used in soft sediments). These dredging methods can be used in mining to maximum depths between 200 and 300 feet. The selection of the mining equipment and methods depend on a number of variables including the character of the deposit, the nature and depth of the overburden (bottom sediments), the association with bedrock, and operational constraints such as geographic location and production requirements. Regardless of the dredging method, the mining generally entails three basic steps: excavation of material; processing and separation of the mineral; and deposition of tailings.

Dredge mining operations are continuous-feed procedures capable of high levels of production. Mechanical dredges are generally characterized by a lack of self-propulsion and lower production rates; however, because they can accomplish precision excavation and perform in restricted areas, mechanical dredges are well suited for placer mining tasks. Dredges may be used for excavation, transportation, concentration of minerals, tailing disposal, and reclamation. A mineral recovery facility can be a part of the dredge operation allowing materials to be washed, crushed, segregated, and discharged onto barges alongside for delivery to distant processing locations. Tailings are typically redeposited astern.

Hydraulic dredges use vacuum pumps to lift a slurry of disturbed bottom sediments and water. In addition to the use of this equipment when extracting specific target minerals (such as gold), hydraulic dredges may also be used to obtain appropriate gravel construction materials. The recovered gravel can be deposited in large bins aboard the dredge or transferred to floating pipelines for transport to an onshore outwash site. Hydraulic dredging equipment is capable of handling large amounts of material in short time periods with the ability to deposit the material at a specific site.

Offshore dredging operations for minerals are essentially self-contained and do not usually require the construction of onshore support facilities. It should be recognized that offshore mining with dredges is subject to accidents due to difficult and unpredictable climatic conditions, including tidal effects, ice movements, and storms.

1.1.3.4 Sand, Gravel, and Rock Mining

Within the Aleutians East CRSA, sand and gravel materials are used in communities throughout the region for roads, building pads, and airstrips and airports. Development activities which necessitate the construction of roads, airstrips, ports, pipelines, transmission lines, offshore islands, breakwaters, jetties, causeways, river training structures, and facility sites will also require the availability of sand, gravel, and rock construction materials. Depending on the construction requirements, these materials may be available as unconsolidated deposits in active river channels, floodplains, abandoned floodplains, beaches, spits, or sea bottom deposits. Where these materials are not available or located at a significant distance from the site of use, extensive transportation systems may be constructed or suitable rock materials available near the development site may be crushed and processed to provide select construction materials.

River floodplains, beaches, spits, and barrier islands are attractive sources of sand and gravel materials due to their wide distribution, ease of access, and lack of overburden. However, these sites of naturally-occurring deposits may also be the most sensitive to sand and gravel removal due to the necessity of operating within flowing water systems, impacts of turbidity and sedimentation on biological resources, and the disturbance of natural processes which originally led to deposition of the sand and gravel material. In addition, removal of sand and gravel from aquatic systems can have a significant impact on the integrity of water sources and important fish habitats and on the hydrology of flowing water systems. The alteration of river hydraulic characteristics through active channel mining, removal of exposed gravel bars, and gravel mining along the banks can induce changes in the location and configuration of active channels. Care must be taken in the siting and operation of floodplain borrow sites to avoid changes in active channel locations which could threaten existing facilities or degrade important biological use areas.

Sand and gravel materials may also be obtained from upland sites such as glacial deposits, abandoned floodplains, and alluvial benches. Rock construction materials are commonly required for projects that must withstand erosion from flowing water, waves, or ice. Riprap, or large blocks of rock, are used in breakwaters, jetties, river training structures (guide banks, spur dikes), bridge embankments, and where erosion protection or stabilization is required. Rock may also be crushed, screened, and washed to produce special purpose select materials.

Offshore mining for sand and gravel from the sea bottom would utilize the same methodology described in offshore mining of mineral deposits (Section 1.1.3.3). Extracted materials could be transported or pumped to onshore storage or use sites, or they may be used in the construction of coastal facilities such as causeways or artificial islands.

The procedures for extraction of sand, gravel, and rock resources are dependent on the type and quantity of material required, its location, the need for processing, and the time of the year. Heavy equipment including dozers, front-end loaders, dump trucks, and scrapers are commonly used where the deposit can be loaded directly onto transport equipment and delivered to the site of use. Where extensive vegetation or overburden is present, disposal sites are necessary to deposit the surface materials removed during clearing and exposure of the gravel deposit. Although most local use material mining sites are relatively small developments which operate for a short period of time, large projects can have significant requirements for gravel, particularly in the construction of roadways, airstrips, and extensive transportation corridors.

1.1.4 MARINE TRANSPORTATION

1.1.4.1 Pipelines

Submarine pipelines are usually installed by special pipelaying barges. They may be either buried or remain on the seafloor surface. High pressure water jets are commonly used to bury pipelines by blowing away the sediment under the line. The pipeline then settles into the trench where the sediment was displaced and is covered over by either backfilling or natural sediment transport process. Dredging can also be used to bury pipelines. When pipeline corridors encounter bedrock, blasting may be necessary. With either method, the seabed is disturbed. Pipelines exposed on the seabed surface present obstructions to trawling activities and can cause gear damage. Natural processes such as current scour can expose buried pipelines. Debris left on the seabed from pipelaying operations can also cause trawling disruptions (Wybrow, Unpublished). Once in place, pipelines are a permanent source of potential obstruction to trawling activities since they are usually not removed after completion of use.

1.1.4.2 Shipping

There are several activities associated with shipping that can potentially impact the Aleutians East CRSA. Shipping sometimes requires that navigational and port improvements be made. Such improvements may involve the installation of navigation aids, the imposition of traffic pattern separation systems, the deepening of channels by dredging, and the development or expansion of port facilities. The discharge of bilge waters from tankers and other waste waters from vessels may affect Aleutians East CRSA water quality and resources. Increases in vessel traffic may result in more vessel collisions.

1.1.4.3 Ports and Harbors

Port and harbor developments can range from small-scale, relatively low impact small boat harbors to major facilities that have the potential to cause significant environmental impacts. Large new ports can result in community population increases and additional infrastructure demands as well as make a substantial contribution to the area's economy. The impacts caused by a port or harbor development depend on the size of the project, its location, the type and number of vessels that it services, the amount of modification required to the sea bottom and shoreline to build and maintain the port or harbor, and the support facilities it requires.

Small boat harbors are usually built to service commercial fishing vessels. They often consist of a series of finger piers or slips that can either be floating or constructed on pilings. Fuel docks and accompanying fuel storage facilities are usually associated with small boat harbors as are sewage disposal facilities. In addition, marine support services (i.e., boat haul out and repair facilities, fishing gear storage facilities, laundry and shower facilities) are sometimes found in association with small boat harbors.

Breakwaters, jetties, and other shoreline structures are sometimes built in conjunction with harbors. Breakwaters are rock structures built to protect the harbor from wave action and keep its water calm. Jetties are built parallel to harbor channel entrances and perpendicular to shorelines to help maintain channel depth. Shoreline structures such as riprap or bulkheads are also sometimes required in harbor areas to control erosion caused by increased vessel traffic and/or changes in water circulation patterns.

Larger ports, used to service commercial traffic and oil tankers, often require additional structures and support facilities, although the specific support facility requirements are primarily determined by the amount and type of cargo that moves through the port. Oil terminals require bulk fuel storage facilities and, in some cases, ballast water treatment facilities. Busy cargo ports (i.e., OCS support bases) may require significant warehouse and outdoor storage space. Ports that serve deep draft vessels such as large oil tankers sometimes require the construction of bulkheads and piers to obtain deep water at the pier.

The major activities usually associated with port and harbor development or expansion are 1) dredging; 2) the construction of bulkheads, piers, jetties, and/or breakwaters; and 3) onshore construction of support facilities for the port.

Dredging (see also Section 1.3.3.1), or the removal of underwater sediments, is often required to create or maintain navigation channels and turning basins, and to obtain source material (i.e., gravel or fill) for pier construction. Most submarine dredging is accomplished by hydraulic dredges that mix sediments with water to form a slurry which is dumped to a discharge point. Mechanical dredges are sometimes used for small projects and are most useful for working in small areas such as near docks and for cleanup work. The dredged material is often used as fill for other project needs. Piers are usually constructed by building bulkheads then placing fill behind them. Loading and storage facilities are often placed on the pier. The construction of facilities such as piers, breakwaters, and jetties all require significant quantities of gravel and/or rock. This material must either be excavated from nearby onshore locations, dredged from adjacent coastal areas, or transported to the facility site from other locations.

1.1.5 TRANSPORTATION AND UTILITY CORRIDORS

Transportation and utility corridors that may be developed to support or facilitate development activities include roads, railroads, pipelines, and electric transmission lines. Since these projects are of a linear nature, there are similarities in the processes of planning, design, and construction activity. Early in the planning process, a general route or corridor is considered based on engineering, economic, and environmental constraints. This process frequently involves the consideration of alternate corridors during the planning phase. Following field reconnaissance, surveys, and soil borings and studies as needed, an alignment is selected within the corridor and detailed information is collected on the topography, geology, and soils. Special purpose surveys may be undertaken to address recognized construction problems, environmental concerns, or special design features such as bridges and stream crossing. Unique requirements of the utility corridor will be identified at this time including sources of gravel construction materials, access and maintenance roads, disposal sites, camp sites, water sources, processing facilities, temporary construction facilities, and permanent facilities such as pump stations, compressor stations, personnel housing, or operations and maintenance facilities.

Essentially all transportation and utility corridors that may be developed within the Aleuatians East CRSA will require surface access for vehicles and equipment during the construction phase and permanent access for maintenance during the operations phase of the project. The lack of an established transportation system to areas of potential development activity will necessitate the construction of roadways within the utility corridor. After an alignment is selected, the portion of the right-of-way needed for roads will be cleared of vegetation by cutting and removal, or through the use of a hydroaxe (mechanical shredder). Based on the specific requirements of the roadway (period of use, necessary width, load capacity, grade, and other design criteria) and the site specific conditions along the alignment (stream crossings, cross drainage, soil stability), a gravel driving surface will be constructed. Construction fabrics and/or insulation may be used to address special construction concerns or to reduce gravel requirements. The mining of sand, gravel, and rock construction materials is discussed in Section 1.1.3.4.

Construction of the roadway could involve significant quantities of gravel materials which may be hauled long distances from a few material sites or obtained at periodic intervals along the transportation or utility corridor. Dump trucks, scrapers, and belly dumps are used to transport gravel from borrow sites as construction of the roadway progresses. Drainage structures are installed at crossings of watercourses; the selection of appropriate drainage structure is based on the anticipated flows, permanence of the structure, icing concerns, costs, and environmental concerns such as passage of fish. The most common drainage structures used are bridges, culverts, and constructed fords or "low water crossings". Bridge structures may range from temporary wooden structures for small streams to elaborate suspension bridges where major rivers are crossed. Construction of bridges and drainage structures may involve in-stream activity with heavy equipment, stream diversions, blasting, placement of embankments and piers, and erosion protection (riprap). Proper siting and construction of roadway and work pad drainage structures is an important part of construction of transportation systems since it can threaten the integrity of the travel surface and watercourse crossing and can detrimentally affect drainage patterns, vegetation, and the fisheries resources of the stream and downstream systems to which it is a tributary.

The construction of highways, access roads, railbeds, and work pads all follow similar procedures with slight variations due to specific development requirements. Railroads have precise limits of grade which significantly influence the selection of the alignment and construction procedures. Transportation and utility corridors generally require year-round access for travel and maintenance.

Electrical transmission lines may not require clearing between support towers if the vegetation will not interfere with operation of the system and the towers are accessed and constructed by helicopter support or overland travel on stable soils. The tower support foundations are the principal locations of surface disturbance.

The most involved utility corridor construction is that associated with the installation of above-ground and below-ground pipelines. Pipelines can be used for oil and natural gas products, water, or mixtures of water and minerals such as coal (slurry pipelines). The construction of pipeline facilities requires a stable working surface for access of heavy equipment, delivery of materials, and construction of the pipeline. In some situations, pipelines may be constructed adjacent to road systems, thereby avoiding the need for a separately constructed work pad surface. The installation of buried pipelines in upland areas follows a relatively standard sequence of events:

- clearing of the pipeline construction right-of-way;
- trenching to the required depth with backhoes, clamshells, or draglines;
- temporary storage of the ditch material adjacent to the pipeline trench or disposal in approved sites;
- stringing, welding, and x-ray of the assembled pipe;
- lowering of the assembled pipe into the trench by sideboom tractors; select "bedding" material may encircle the pipe and/or concrete weights may be installed to eliminate pipe buoyancy in wet situations;
- backfill of the trench with excavated ditch materials or imported select materials;
- hydrotest of the installed pipe; and
- restoration of the disturbed surface, stabilization for erosion, and revegetation.

Where pipelines are installed on above-ground supports or gravel berms, the activities associated with trenching and backfill are not performed. Activities that occur concurrent with the pipe installation include special procedures for crossing of active rivers and streams, operation of construction camps and support facilities, operation of material mining and processing sites, development of waste disposal sites, and construction of permanent facilities for operation such as pump stations (oil) and compressor stations (natural gas).

1.1.6 ALTERNATE ENERGY SOURCES

Alternate energy sources which may be available to supplement or replace generation of electrical power by fuel-fired generators include wind, geothermal, and hydroelectric power. While fuel-fired generating systems can be developed in any location, specific factors must be present to take advantage of the potential energy generating capability of natural climatic conditions, geologic phenomena, or hydrologic conditions. In some instances, alternate energy power may be more practical in remote locations where availability of fuel is limited or is very expensive.

1.1.6.1 Wind Energy

To generate electrical power by wind, an air flow (wind) rotates the blades of a collector which drives a generator to produce electricity. Wind machines must have airfoil blades similar to those of an airplane propellor to attain the high speeds necessary for electrical generation. The blade rotation can be either horizontal (as in a windmill) or vertical. The electricity produced can be either alternating current or direct current, the latter having the capability to be stored in small capacity batteries.

Since winds are rarely continuous, wind generation of electrical power must be backed-up by another generation source. This back-up power source is usually a diesel-fired generator. Wind generators have a high initial cost, are continuously exposed to weather, and require more frequent maintenance than conventional fuel-fired power generation systems.

A combination of alternative energy sources can be combined to provide a continuous supply of electrical power. For instance, wind-generated power could be used to pump water to a reservoir that would support subsequent generation of hydroelectric power.

The physical structure required for development of wind power consists of a tower, rotating blades, and small facility to house the electric generating unit. Support and storage facilities are not required.

1.1.6.2 Geothermal Energy

Geothermal energy is derived from a naturally occurring heat source such as subterranian hot water or steam. The development of geothermal energy as a source of power depends on the presence of a geothermal heat source in proximity to the proposed area of power use. Heat provided by the geothermal source can be used for residential and industrial heating, gardening, or to power turbines which generate electricity. To operate the turbines, the geothermal heat source must be of a sufficient temperature and volume (output) to support the system. In Alaska, the use of geothermal energy is in preliminary stages of evaluation and development.

1.1.6.3 Hydroelectric Development

Hydroelectric power is generated by water flowing from a higher to a lower elevation. The flowing water spins a turbine which, in turn, drives a generator producing electricity. Hydroelectric developments can be of two types: 1) conventional, or those that use water only once, and 2) pump-storage which cycle water between an upper and lower reservoir. Plants can range in size from "estate-size" units capable of producing around one kilowatt of electicity to huge dam systems which can generate many thousands of kilowatts. The size and type of the systems is determined by the characteristics of the site, the need for power, and economic constraints.

There are two types of conventional systems: run-of-river and storage. A run-of-river plant uses naturally occurring stream flows modified by an impoundment or diversion. A storage system has enough storage capacity at the plant to regulate stream flows by storing water at times of high flows and releasing it during low flow periods.

Pumped-storage projects can be classified as either "on-stream" or "off-stream". In an on-stream system, some water is pumped from the river on which the plant is located to the reservoir above the dam. In an off-stream system, water is pumped from a lower reservoir on the stream to an upper reservoir located away from the stream. Both systems allow release of water over and above that in the stream itself during times of peak power demand.

Hydroelectric projects usually consist of: a dam, an impoundment, a penstock, a power house, and transmission facilities. Aspects of construction of transmission lines are discussed in Section 1.1.5. Dams are usually concrete, earthfill, or a combination of the two. Penstocks are pipelines or trenches which conduct the water to the powerhouse.

Construction of a power system involves bringing workers and heavy equipment to the site. Roads and, if no suitable facilities are available, camps to house the workers must be built. If the dam is to be earthfill, a source of competent material must be located and access constructed to it. Earthfill dams are usually composed of impervious cores covered with large rip-rap to armor the structure. Requirements for materials are very exacting since the integrity of the dam depends upon it. Concrete dams require sand and gravel sources but do not have the same requirements for large rock as do earthen dams. Dam construction often involves bank cutting and blasting to achieve the correct configuration of river banks and bed. The river may be diverted into another channel during construction or temporarily blocked by a smaller earthen structure in the future reservoir area. Heavy equipment then begins the process of bringing material to the site to build the dam itself while powerhouse and penstock construction takes place at the same time.

The area to be covered by the impoundment is usually cleared of large vegetation and debris that could interfere with operation of the flow control and generation facilities. In the case of large projects, impoundments can be many miles long, changing formerly terrestrial habitat to aquatic habitat. Penstocks can be a system of troughs and trenches in an area fairly close to the dam itself or a pipeline system to take water to a powerhouse as much as several miles away. Usually, in this case, water that has been run through the powerhouse is discharged back into the stream from which it originally came or, sometimes, into another stream or other area.

1.1.7 COMMERCIAL FISHERIES DEVELOPMENT

The term "fisheries development" includes a wide variety of activities; some activities are physical like dock construction, others are economic, and still others are political. This section discusses the physical activities and environmental consequences associated with fisheries development. While the harvesting, processing, and support sectors of the fishing industry are addressed separately, it must be emphasized that they are interdependent and activities in all sectors occur coincidentally.

The expansion of existing fisheries or the development of new fisheries may result in the conversion of existing vessels, and/or in new boats joining the fleet. New boats will require harbor space and support facilities (for example fuel and maintenance services). In addition, the development of new fisheries may attract new fishermen to the area. New fisheries may introduce additional gear to already utilized fishing grounds, potentially resulting in use conflicts between fisheries.

Fisheries development may also require new processing facilities or the significant expansion of existing facilities. Seafood processing plants generally require a shorefront location with adequate docking facilities for fish deliveries, supply barges, and vessels that transport products to market. Plant construction is similar to other construction projects. Bunk houses are often built in conjunction with seafood processing plants to accommodate non-resident workers. Seafood processing plants typically have large water requirements. While salt water can be used for many processing needs, fresh water is needed for cleaning and final rinsing. Reliable power is also a key requirement of a processing facility. Seafood processing plants produce large quantities of waste. Environmental Protection Agency (EPA) regulations governing the discharge of fish waste into coastal waters in "remote" sites (where there are less than four processing plants) allow for the direct discharge of the waste into coastal waters. When an area is no longer classified as remote, alternative waste disposal techniques must be used. Alternatives acceptable to EPA include dumping the waste in designated offshore dump sites and product conversion, i.e., processing the waste into fishmeal.

Fishermen and processors require a variety of support facilities and services. Examples of service businesses include bulk fuel storage and supply, indoor storage and gear lockers, warehouses, outside crab pot storage areas, workshop and repair facilities, and boat haul-out facilities. Seafood processors sometimes provide some of these secondary services to fishermen, especially when they are located in a remote location. Secondary support facilities enhance a port's ability to attract more traffic and business.

1.1.8 RECREATION AND TOURISM

Recreation is defined in this document as a non-consumptive use of fish and wildlife and includes hiking, boating, sightseeing, photography, birdwatching, beachcombing, and similar activities. These are primarily casual activities indulged in by groups of people and are not the result of organized efforts. Tourism may involve the same activities but they are carried out by persons who are not residents of Aleutians East CRSA.

Types of development which may accompany an increased interest in recreation and tourism in the Aleutians East CRSA are the following:

- Construction of lodges, hotels, and restaurants. The latter two will primarily occur in the communities, whereas lodges are more remote establishments.
- Development of campgrounds, parks, and trails. It is likely that these facilities would be accessible primarily by plane or boat and could grow up around previously existing points of interest such as hot springs which are used for bathing.
- Establishment of boat tours of scenic areas or bird and marine mammal colonies.
- River float trips.
- Construction of privately-owned cabins.

The primary attraction to tourists is the area's wild and remote character. It is likely then that future recreational developments will seek to preserve these attributes especially in areas located away from communities.

1.1.9 SPORT FISHING AND HUNTING

Development related to sport harvest of fish and wildlife consists mainly of increased access to hunting and fishing areas and construction of facilities to house sportsmen. It is not anticipated that utilization of the resources by the area's residents will increase unless there is an influx of people due to development of oil and gas, minerals, or commercial fishing. These kinds of developments would increase the population of Aleutians East CRSA and would also stimulate transportation and related industries, creating a new infrastructure which could be used by visitors to the region.

At present, the area's remoteness is both its chief attractions and one of its major drawbacks. Hunters seeking a wilderness experience hunt on Unimak Island, especially, for brown bear and caribou. Waterfowl hunting in the Cold Bay area has remained at good levels in recent years and does attract hunters from outside the area. Sport fishing, except by residents, remains underexploited because access is lacking and because the variety of species available to catch in the Aleutians East CRSA is less than further north on the Alaska Peninsula and in the Bristol Bay area.

Future development will most likely consist of building lodges for fishermen and hunters, airstrips, campgrounds, and private cabins. Campgrounds will probably be of the wilderness type, i.e., cleared areas near a water source with pit privies (if any). Both lodges and campgrounds will be most likely reached by air or by boat - very little road construction is anticipated. If, however, roads are developed for other purposes, it can be expected that hunters and fishermen will exploit the newly accessible areas.

1.1.10 LAND DISPOSAL

As part of a statewide program to make more land available to state residents, the Alaska Department of Natural Resources periodically conducts disposals of state lands. The resulting activities and impacts of these sales largely depend on the purpose and conditions of the sales. Sales for remote settlements usually attract buyers from both within and outside the region who wish to build recreational cabins. Such cabins are rarely primary residences and create no new infrastructure demands, rather they are most often used as bases for hunting and fishing activities. Because these sales are in remote locations, all building materials must be transported to the site. Remote settlements can result in increased human activity in previously undisturbed wilderness areas and increased hunting and/or fishing pressure on fish and wildlife populations.

Land sales adjacent to existing communities are most often for community expansion or commercial development. When extensive tracts of land are made available, population increases may occur. Such sales may result in a variety of construction activities, increases in the number of households within a community, and increased demands for services. In addition, people from outside the region may move into the area, changing both the demographics of a community and the community lifestyle and culture.

1.2 IMPACT IDENTIFICATION

The matrix presented in Exhibit 1 shows the association between development activities described in Section 1.1 and the impacts from development activities which are discussed in Section 1.3. The types of development activities are presented in the left column of the matrix, and categories of potential impacts to natural resources are identified along the horizontal axis. Dots placed in the appropriate boxes indicate the impacts which may occur as a result of a particular development activity. Until the details of a project are known, specific impacts cannot be identified. Some general methods of minimizing impacts are also presented in Section 1.3.

CATEGORIES OF POTENTIAL IMPACT TO RESOURCES

COASTAL ACTIVITIES	Disturbance of Fish Populations	• Barriers to Movement	• Blasting	• Seismic Testing	Disturbance of Wildlife Populations	• Activity	• Noise	• Migration Impediments	Marine & Aquatic Habitat Alteration	• Dredging & Filling	• Shoreline Modification	• Flooding & Dewatering	• Channel Alteration	• Sedimentation	Terrestrial Habitat Alteration	• Habitat Loss	• Erosion	Water Pollution	• Oil	• Siltation	• Sewage	• Heavy Metals/Toxic Substances	• Seafood Processing Wastes	Air Pollution	Human/Animal Interactions	Cultural Impacts	Community Infrastructure	Visual/Aesthetic	Historical/Archaeological Sites	Commercial Fishing	• Fishing Ground Preemption	• Gear Damage and Loss	• Catch Tainting
Outer Continental Shelf Oil & Gas			●	●		●	●			●	●			●					●	●		●				●	●	●			●	●	●
Submerged Land, Tideland & Upland Oil & Gas		●	●	●		●	●	●		●	●			●		●	●		●	●	●	●			●	●	●	●	●		●	●	●
Lode Mining			●			●	●							●		●	●		●	●	●	●		●	●	●	●	●	●				
Placer Mining		●	●			●	●			●	●	●	●	●		●	●		●	●		●		●	●			●	●				
Offshore Mining			●	●		●	●			●	●			●		●			●	●		●									●	●	
Sand, Gravel & Rock Mining			●			●	●	●		●	●	●	●	●		●	●		●	●				●				●	●				
Marine Pipelines			●							●	●			●					●	●											●	●	●
Shipping						●				●									●													●	
Ports and Harbors		●	●			●				●	●	●		●		●	●		●	●	●					●	●	●	●				
Transmission Lines						●	●	●						●			●									●		●	●				
Roads		●	●			●	●	●		●	●	●	●	●		●	●			●	●			●	●	●	●	●	●				
Onshore Pipelines			●			●	●	●		●	●	●	●	●		●	●		●	●	●			●	●	●	●	●	●				
Wind Power																											●	●					
Geothermal Power							●															●		●			●	●	●				
Hydroelectric Power		●	●					●		●	●	●	●	●		●	●			●					●		●	●	●				
Commercial Fisheries Development																							●			●	●				●	●	
Recreation & Tourism						●	●																		●	●	●						
Sport Fishing & Hunting, Subsistence						●	●																		●								
Land Disposals						●				●	●					●									●	●		●	●				

1.3 IMPACT DESCRIPTIONS, SENSITIVE NATURAL RESOURCES, AND METHODS FOR REDUCING IMPACTS

1.3.1 DISTURBANCE OF FISH POPULATIONS

1.3.1.1 Movement Blockage

Blockage of movements of fish within a river, lake, or along the marine coast can occur as a result of physical obstructions, water velocity, thermal barriers, or pollution. Water pollution is discussed in Section 1.3.5. Fish undertake seasonal movements to feed, rear, overwinter, and spawn. Some species like salmon undertake dramatic spawning runs up rivers to historical spawning areas. Other fish move seasonally between rivers, lakes, and estuaries or within rivers to utilize productive feeding areas and/or to overwinter in deeper or warmer waters which do not freeze. When these movements and migrations are disrupted, consequences to the population may be significant.

Dams intended to impound water of streams or rivers are obstructions to fish movements. The obstruction may be permanent (i.e., flood control or hydroelectric dams) or it may be a temporary structure for a construction activity. Unless in-stream dams are provided with fish ladders or alternate fish passage channels, fish populations may be precluded from use of upstream habitats.

Roads can be barriers to fish passage when they are built across rivers and streams. If stream channels are not clearly marked prior to construction activities, stream channels may not be recognized and, therefore, no drainage structure is provided or it is placed in the wrong alignment. Either of these errors results in total blockage of streams. This is a particular concern in wetland areas where stream channels are hard to discern, when surveys are conducted during times of snow cover, and where streams are very small.

inappropriate or incorrectly installed drainage structures also can block fish passage (Bell 1973, Lauman 1976, Dane 1978). Culverts are a commonly used drainage structure of round or oval corrugated metal pipe. Culverts must be correctly installed so that fish can move upstream and downstream unimpeded. If the culvert is not properly buried in the streambed, its outlet may be perched above the stream creating a waterfall which prevents fish passage upstream.

Culverts that are not properly sized to handle anticipated volumes of flow often are incapable of passing spring floods. In this case, the road may wash out and deposit gravel in the downstream channel blocking fish movements. Culverts that are too small usually concentrate the flow of the stream so that the velocity of the water flowing through is too great to allow fish, especially smaller species and younger age classes, to pass through (Bell 1973, U.S. Fish and Wildlife Service 1979). This is a "velocity barrier" to fish passage. Disturbed streambeds that are wider than the natural channel can spread out flow such that larger fish have difficulty passing through the shallow water.

Bridges are preferable to culverts because they allow unobstructed flow of water and passage of fish (Lauman 1976). If bridge supports are placed within a narrow channel, they may constrict flows and increase water velocity or accumulate debris which could create a barrier to fish movements.

Other causes of fish movement blockages include the creation of depressions during gravel removal which may trap fish as water levels recede, and the blockage of tributary stream channels and side channels by spur dikes and revetements.

Sensitive Environments and Populations

Streams inhabited by fish are sensitive to all types of channel blockage. The severity of the blockage impact is related to the fish species involved and the time of year. Streams used by salmon, Dolly Varden, and steelhead are particularly sensitive since it is imperative for adults to move unrestricted to their spawning areas and, in the case of Dolly Varden and steelhead, to overwintering areas. Juvenile fish must also be able to migrate to rearing areas. Tributary streams may not be inhabited by adult fish, but access to rearing habitats for juvenile fish is essential.

Methods of Minimizing Impacts

Some general ways of minimizing or avoiding blockage of fish movements are the following:

- Install bridges rather than culverts or low water crossings whenever possible. Bridge approaches and supports should be located outside the stream channel.
- Culverts should be sized and installed so that they allow up- and downstream passage of all species and age classes of fish which inhabit the waterbody.
- Temporary blockages (i.e., flumes, diversions, and dikes) should not occur during critical life history events such as upstream spawning migrations or juvenile out-migrations.
- River training structures should be located away from tributary streams.
- Depressions created during floodplain gravel mining should be filled to avoid fish entrapment.

1.3.1.2 Blasting

Explosives are sometimes used during construction projects, seismic testing in upland areas for oil exploration, oil field abandonment (to sever wellheads), excavation for gravel and other mining, and trenching activities for pipelines. Different kinds of explosives are used for different projects but all high explosives (e.g., dynamite, primacord, TNT) have essentially the same impacts on fish (Sundberg 1984). Fish can be adversely affected by blasting which occurs either in or out of water, although blasts which occur in the water usually cause greater impacts. The damage is caused by the blast shockwave which is transmitted through the earth, air, or water. Transmission of the shock wave is affected by the substrate, i.e., transmission through water differs greatly from that through ice, sand, rock, or clay. Shock waves are transmitted much greater distances through water than through denser mediums (Starr et al. 1981).

Fish may be killed or injured by the effects of underwater explosions in several ways. Damage resulting from pressure changes may range from minor (loss of scales and minor blood vessel rupture), to severe (tearing of muscle tissue, rupture of the abdominal cavity, blood vessels and internal organs, and disruption of the nervous system), to immediate mortality (Falk and Lawrence 1973). If a fish is injured and disabled rather than immediately killed by a blast, it is more vulnerable to predation (Hill 1978; Teleki and Chamberlain 1978).

The major cause of death and injury to fish from blasting occurs as a result of ruptured swim bladders. The swim bladder is an air-filled membrane sack which keeps the fish afloat and helps maintain stability. It is very sensitive to the rapid changes in pressure that accompany blast shockwaves. Pressure tests with live fish indicate that a peak pressure of 40 to 50 pounds per square inch (psi) from a high explosive charge is usually fatal to adult fish with swim bladders (Hubbs and Rectnitzer 1952). A peak pressure as low as 2.7 psi will kill juvenile salmon and herring (Rasmussen 1967). The "kill zone" for fish that results from a within-water explosion extends a considerable distance away from the blast site and is dependent on the magnitude and location of the blast, water depth, and species and life history stages of the fish present.

Sensitive Environments and Populations

Habitats in which fish spawn, hatch, rear, and migrate are all extremely sensitive to the impacts of blasting. Such habitats include anadromous fish streams, enclosed lagoons, estuaries, and shallow coastal waters.

Fish with swim bladders are most sensitive to the effects of blasting. All species of fish important to commercial fishing in the Aleutians East CRSA have swim bladders (Trasky 1976). In general, small fish, fish with closed swim bladders, and fish with thin-walled swim bladders are more sensitive to mortality from blasting than are large fish. Pelagic fish such as salmon and herring are more sensitive than groundfish species such as halibut. In some cases, such as with salmon and herring, larvae fry that have not yet developed swim bladders are less vulnerable to damage from blasting than are juvenile fish with newly developed swim bladders (Rasmussen 1967; Falk and Lawrence 1973). For salmon, swim bladder development is completed by the time fry emerge from the gravel. Similarly, larval marine fish are less sensitive to blasting than are juvenile marine fish (Wright 1982).

Salmon eggs are also extremely sensitive to shock from the second day of fertilization until the pigment is formed in the eye (this is a relatively short period of time and is temperature dependent); eggs subject to shock or movement during this time will probably die (Trasky 1976).

Methods of Minimizing Impacts

Some general ways of avoiding or minimizing adverse impacts to fish populations from blasting are:

- Alternatives to blasting should be investigated prior to allowing the use of high explosives.
- Prohibit the use of high explosives in shallow marine waters where fish eggs, juvenile fish, or adult fish are present.
- Avoid the use of high explosives in and near streams where fish eggs are developing and when populations of fish are in the vicinity.
- Where upland blasting is necessary adjacent to fish habitat, high explosives should be (1) detonated in a series of delayed smaller charges rather than one large explosion; and (2) follow standard set-back requirements of the Alaska Department of Fish and Game.
- If blasting is necessary, it should be scheduled during periods when significant fish populations are not present in the area.
- If high explosives are used in upland areas near streams, keep fish away from the blast area through the use of nets, temporary dams, or river diversions.

1.3.1.3 Seismic Testing

Seismic testing usually occurs during the pre-lease and exploratory phases of oil and offshore mining development (see Sections 1.1.1., 1.1.2, and 1.1.3.3). The effects of seismic exploration on fish vary considerably depending on the methods employed. Use of high explosives, especially in shallow water, is generally lethal to nearby fish (Lewbel 1983). Section 1.3.1.2 discusses impacts of the use of high explosives on fish. Non-explosive techniques (e.g., water or air guns) are usually used in the marine environment, and the Alaska Department of Natural Resources has not issued a permit for use of explosives as part of seismic testing programs in open water since December 1975. Non-explosive seismic techniques have proven adequate for nearly all open water seismic testing, although some industry sources indicate that such techniques are not always effective in waters shallower than 40 feet where large waves and high tides occur (Sohio Alaska Petroleum Company 1984). The vibroseis technique and sometimes explosives are used for upland seismic surveys and surveys conducted over ice. Non-explosive seismic techniques do not appear to physically injure fish, although observations by ADF&G personnel (Sundberg 1984) suggest that the noise they produce may cause salmon to move away from the pathway of a ship towing seismic equipment. Seismic tests that use explosives as a sound source have the same impacts on fish populations as blasting. Overpressures from terrestrial seismic explosions can kill fish if detonated in or near lakes and streams. Seismic testing in marine waters requires the use of vessels and equipment that can physically interfere with commercial fishing activities.

Sensitive Environments and Populations

If explosive techniques are contemplated, the same sensitivities discussed in Section 1.3.1.2 are applicable. It should be emphasized that the use of explosives for seismic testing significantly increases the impacts of this activity on important fish populations. Impacts of seismic testing on wildlife (including marine mammals) are discussed in Section 1.3.2.

Offshore seismic operations can physically interfere with commercial fishing activities if both occur simultaneously. Seismic testing vessels must stay on track and the long tow cables can sever buoy lines and interfere with trawling activities. Careful planning and good communication can eliminate most conflicts (Representatives of Alaska Oil and Fishing Industries 1983).

Methods of Minimizing Impacts

Methods for minimizing the impacts to fish from seismic exploration include:

- Prohibition of the use of explosives as a sound source for seismic surveys in open waters. If explosives must be used in upland surveys near aquatic systems, blasting programs should be scheduled when significant populations of fish are not present. The program should also be designed to reduce energy transmitted to surrounding waters (see Section 1.3.1.2).
- Coordinate seismic testing programs among operators to reduce duplication.
- Temporally and geographically separate seismic testing and fish harvest activities.

1.3.2 DISTURBANCE OF WILDLIFE POPULATIONS

1.3.2.1 Activity

During exploration, construction, and operation of development sites and facilities, the physical presence of equipment, machinery, ships, aircraft, motor vehicles, and human beings can preclude the use of specific sites or areas important to wildlife populations (Bromley 1982, Hanley et al. 1980). Disturbances may be restricted to a discrete location or they may extend over long distances when linear projects such as roadways, pipelines, and transmission lines are involved. It is difficult to separate the specific effects of increased activity on wildlife populations since noise is usually an accompanying factor. Development activities in flat terrain or areas devoid of visual barriers (such as the presence of tall vegetation or trees) may be more disturbing to terrestrial wildlife species than similar activities where visibility is obscured by topography or vegetative buffers.

Disturbance resulting from offshore developments is generally restricted to the sites of activity, but requirements for materials transportation and support activities can create more wide-ranging disturbance along aircraft and shipping routes. The visual presence of facilities in offshore areas extends for significant distances due to the lack of relief on the ocean surface.

For most development projects, potential disturbance to wildlife populations is greatest during periods of construction when more equipment, materials, vehicles, aircraft, and human beings are usually present. The level of activity generally decreases during operation of development facilities such as pipelines, offshore oil and gas platforms, transmission lines, and processing facilities. For some facilities such as oil transfer terminals, onshore activity may be greatly reduced after construction is complete, while marine traffic from tankers and transport ships may increase offshore disturbance significantly.

Sensitive Environments and Populations

Wildlife populations differ greatly in their sensitivity to activity generated by development projects depending on the species, the time of the year, and the precise location of disturbance activities in relation to sensitive use areas and habitats.

The reaction of wildlife to visual stimuli varies between species and may even be different between sexes within a species. Some wildlife are adaptable to disturbance activities and the presence of structures and human beings (Hosking 1984). Moose are recognized as a relatively adaptable animal; however, during the spring calving period, this species can be quite secretive and vulnerable to disturbance. Studies of caribou on the North Slope of Alaska have indicated some level of accommodation by bull caribou to the presence of physical structures, pads, pipelines, and roads. However, this ability to acclimate to disturbance activity and visual stimuli is apparently not shared by cow caribou with calves since they generally remain in areas removed from disturbance activities and development facilities (Cameron and Whitten 1977).

Some marine mammals have been shown to be vulnerable to disruptions caused by development activities. Helicopters, low-flying aircraft, boat traffic, and human presence have been associated with pup mortality and declining use of some habitats by marine mammals (Johnson 1976, Salter 1979, Taggert and Zabel 1982). Belukha whales have been temporarily disrupted by barge traffic during construction of offshore islands in the Canadian Beaufort Sea; rapid movement away from barge traffic was noted 1.5 miles away from the barge course (Fraker 1977).

Moose, caribou, and brown bears all react to overflights by helicopters and fixed-wing aircraft (Calef et al. 1976, Geist 1971). Disturbance of caribou and moose decreases with increasing altitude of aircraft suggesting that noise may be more important that the visual stimuli. Grizzly bears are more sensitive to disturbance by aircraft than either caribou or moose (McCourt et al. 1974).

Brown bears may prematurely emerge from den sites or increase activity within dens due to direct disturbance, vehicle noise, aircraft, or seismic-related detonations of explosives (Harding and Nagy 1980, Reynolds et al. 1983). Brown bears are also vulnerable to disturbance and harassment when concentrated in relatively limited early spring feeding areas and summer feeding concentrations along selected salmon streams.

Waterfowl exhibit varying degrees of sensitivity to low-flying aircraft, especially during staging, nesting, and molting (Sellers 1979, Barry and Spencer 1976). Birds disturbed by activity or human presence may either abandon or discontinue use of favored breeding, feeding, nesting, staging, and molting areas.

Marine and terrestrial wildlife may not acclimate to areas of continual activity, particularly if the disturbance sites are situated near locations of sensitive life history activities.

Methods of Minimizing Impacts

To minimize the impacts of disturbance activities on marine and terrestrial wildlife, the following general guidelines should be used in the siting of facilities and the conduct of development activities:

- Site facilities away from highly sensitive wildlife habitats and use areas including seabird colonies; waterfowl and shorebird nesting, molting, and staging areas; peregrine falcon nesting areas; marine mammal haul-outs; winter concentration areas for moose; caribou calving areas; and brown bear denning areas.
- Site facilities where physical barriers such as terrain will minimize disturbance to caribou migration routes and use areas.
- Conduct development activities with high levels of visual disturbance during periods of least biological activity.
- Avoid or minimize low level flights by helicopters and fixed-wing aircraft over sensitive wildlife species or habitats; insure that harassment of wildlife is avoided.
- Route marine transportation and support activities to avoid concentrations of marine mammals during critical periods and in sensitive habitats of limited availability such as rookeries and haul-out sites.

1.3.2.2 Noise

During reconnaissance, exploration, construction, and operation of development facilities, noise generated by helicopters, fixed-wing aircraft, machinery, heavy equipment, and blasting produces varying degrees of disturbance to marine and terrestrial wildlife. The activities which are associated with noise-generating sources include all development projects in offshore and onshore habitats. Noise disturbance is generally greatest during exploration and development activities when construction equipment, aircraft and boats, and human presence is greatest. During operation and production, noise sources may decrease and/or change to sustained or continuous levels. The characteristics of noise vary with its amplitude and frequency, and whether it is pulsed or non-pulsed. Potential disturbance to wildlife can occur from both airborne and underwater noise. Behavior studies of herring have shown that even some species of fish may show strong nervous reactions in response to underwater noise (Olsen 1971).

The intense level of support activity associated with offshore oil and gas exploration and development results in noise sources that can potentially affect a variety of wildlife use areas and populations. During geophysical exploration, noise is generated by boat traffic, aircraft, and seismic activities. Noise generated by geophysical exploration has been recorded up to 40 kilometers from its source (Cowles et al. 1981). Ships used for support services, geophysical work, and transport generate noise from their propulsion systems; this noise is transmitted to the surrounding waters. Large Arctic-class tankers are thought to produce detectable noise in a 30,000 square kilometer area. Underwater noises associated with offshore oil operations, artificial island construction, semi-submersible platforms, crew boats, tug and barge traffic, and suction dredges can cover a broad frequency range and are capable of reaching 30 to 50 nautical miles from the source before being weakened (Cowles et al. 1981). Airborne noises associated with offshore oil and gas development are derived primarily from helicopters.

Onshore developments including personnel support facilities, transfer and storage sites, transportation corridors, oil and gas projects, and mining activities generally include noise-generating sources. Explosives and vibrating equipment may be used during terrestrial seismic work. Explosives may also be used in mining activities for minerals or in production of building materials for coastal developments and erosion protection. Blasting for quarry rock on the Terror Lake Hydroelectric Project discouraged nesting by raptors during the year of construction activity (Hosking 1984). Any surface-disturbing activity which utilizes heavy equipment for construction or transport is a source of noise. Fuel-fired power generation facilities and pump/compressor stations are stationary noise sources in place for extended time periods.

Sensitive Environments and Populations

Wildlife populations are most sensitive to impacts from noise when it occurs during a sensitive or vulnerable life history stage, or near a sensitive use area or habitat. Marine and terrestrial wildlife disturbed by noise may discontinue use of preferred breeding, feeding, nesting, pupping, calving, staging, molting, or denning areas. The availability of seasonal use areas which provide specific life history requirements may be limited; hence, loss of habitat attributable to noise disturbance can affect reproductive success and the viability of specific wildlife populations.

Wildlife can be affected by loud and unpredictable noise (startling sounds) such as rapidly approaching boats and aircraft, explosions, gas compressor station "blow-down", or gunshots. Nesting waterfowl and seabirds are particularly vulnerable to startling noises which can result in direct mortality to eggs and young through destruction, abandonment, or increased susceptibility to predation during the absence of the parent bird (LGL Limited 1972, Mickelson 1975). Egg mortality can also occur when exposed eggs become overheated or chilled after parents have been driven from the nest. Molting birds are vulnerable to noise disturbance since they are under considerable physiological stress during their flightless period. Birds actively feeding on staging areas are replenishing fat reserves lost during spring migration (and prior to nesting) or preparing for extended migrations south in the fall. Loss of access to these important seasonal feeding and resting areas due to noise disturbance can seriously affect productivity and survival of adult birds.

Offshore developments that generate noise can have adverse effects on marine mammals which occupy consistently used haul-out areas and pupping rookeries. Harbor seals are susceptible to disturbance from low-flying aircraft noise and are noted for mass departure from haul-out areas in the event of such disturbance (Johnson 1976). Repeated aircraft noise disturbance of harbor seal haul-out areas could lead to eventual abandonment of such sites. Harbor seals are also vulnerable to any loud or sudden noise which can lead to desertion of a haul-out by the seal herd and abandonment of young pups. Walrus are reported to leave haul-out areas in response to harassment and noise (Salter 1979, Taggert and Zabel 1982); continued disturbance may prevent recolonization of traditional haul-out areas. Belukha whale observations suggest sensitivity to noise from aircraft as well as boats. Many marine mammals appear to be highly dependent on the underwater acoustic environment for communication, location of food, spatial orientation, and avoidance of predators. It is likely that most marine mammals are capable of detecting underwater sounds given adequate amplitude. Based on assumed hearing sensitivity, bowhead whales may be able to detect drilling noises (Cowles et al. 1981). Whales may respond to and avoid noise sources which produce a sudden, variable pulse and/or high amplitude noise (Cowles et al. 1981). Gregarious toothed whales typically respond to sudden noise disturbance by sounding, dispersion, and regrouping.

Noise associated with seismic exploration in areas of shorefast ice occupied by pupping ringed seals has been shown to reduce the density of ringed seals where over ice seismic surveys and other activities have occurred. The observed decline in density was thought to be caused by displacement away from the sound source rather than direct mortality to adult ringed seals. However, abandonment of pupping lairs in the shorefast ice due to noise disturbance could decrease the ringed seal population in that area since newborn pups are totally dependent on the female for the first six weeks after birth. Premature departure from maternal dens in the vicinity of seismic operations has also been noted for polar bears. Early den desertion may adversely affect the survival of polar bear cubs (Burns et al. 1980).

Terrestrial mammals such as caribou, moose, and brown bear are susceptible to noise disturbance during sensitive life history stages such as calving, denning, and concentration on critical winter ranges. Startling and sustained noise sources that delay or discourage occupation of the calving grounds by caribou could significantly impact the productivity of the herd. While moose appear to be more tolerant of noise, they are still sensitive to it during spring calving. Both caribou and moose may be detrimentally affected by noise disturbance when occupying critical winter range. The environmental conditions and forage available to these wildlife on limited winter range may not be available in other locations if they are discouraged from use of preferred areas.

Brown bears are vulnerable to noise disturbance and harassment when concentrated in relatively limited, early-spring feeding areas and summer feeding concentrations on salmon streams.

Methods of Minimizing Impact

Methods of minimizing disturbance to wildlife from development activities include:

- Noise generating activities such as helicopters, fixed-wing aircraft, boat traffic, blasting, geophysical activities, and construction should be scheduled and sited to avoid sensitive life history stages and use areas for wildlife.
- Where sensitive biological populations are present, seismic exploration should be conducted using only non-explosive techniques.
- Seismic activities in coastal areas should avoid disturbance to the shorefast ice zone during occupation by pupping ringed seals.
- Startling noise sources should avoid seabird colonies; waterfowl and shorebird nesting molting, and staging areas; marine mammal rookeries and haul-out sites; caribou calving areas and critical winter range; and brown bear spring use feeding areas and fish stream concentration areas.

1.3.2.3 Migration Impediments

Marine and terrestrial wildlife populations which conduct predictable, seasonal movements between important use areas or habitats during relatively limited time periods are vulnerable to events or structures which delay or preclude migration movements. Migration impediments may be physical barriers, visual barriers, or activity/noise barriers.

Sensitive Environments and Populations

Terrestrial wildlife which utilize restricted migration zones are most vulnerable to migration impediments. Delays or obstructions to migration can prevent timely arrival at breeding areas, access to important feeding sites, or timely departure prior to sea ice formation. Since most species of birds and marine mammals migrate along broad fronts, blockage of seasonal or annual migratory movements by development activities is not likely. However, where relatively restricted passes or straits are used by a significant portion of a wildlife population and alternative routes are not readily available, blockage to migration movements can occur.

An unusual form of impediment to free movement has been reported for belukha whales and potentially for other sonar-oriented marine mammals. Suspended microbubbles in heavily-used boat corridors may produce sonar-reflecting barriers which persist for several hours after the passage of ships. Belukha whales may avoid heavily used barge or ship routes in nearshore areas (Starr et al. 1981).

Caribou are potentially the most vulnerable terrestrial mammal in Alaska to the impacts of migration impediments. Studies on the North Slope of Alaska have shown the sensitivity of caribou to above-ground pipelines, roadways and associated activity, and structures/facilities in the vicinity of migration corridors (Cameron and Whitten 1977, 1982; Curatolo et al. 1982). Although bull caribou appear to acclimate to activity and facilities, pregnant cows and cows with calves generally avoid facility and activity sites (Cameron et al. 1983). When the development-related activity is linear (such as a road, pipeline, or transmission corridor), it can effectively function as a migration barrier, particularly in association with the noise and activities that accompany such developments. Delay or obstructions to free movement from critical wintering habitat to preferred calving areas can cause a reduction in herd productivity through birth of calves in inappropriate habitats or nutritional stress due to inability to reach early emergent, high-quality forage in the spring (Cameron

1983). Obstructions to caribou movements from widely dispersed summer feeding areas to critical wintering habitats can result in direct mortality by starvation during the winter.

Methods of Minimizing Impacts

Methods of minimizing impacts to wildlife from migration impediments include the following:

- Avoid the siting of facilities or linear developments adjacent to or intersecting important caribou migration corridors.
- Schedule potentially disturbing construction activities that occur in the vicinity of restricted migration corridors during non-sensitive time periods.
- Minimize operation and maintenance activities and traffic in the area of important migration zones during sensitive periods, particularly if alternate migration corridors are not available.
- Consider the cumulative effects of all boat, barge, and tanker traffic within important marine migrational corridors and avoid excessive marine traffic during the seasonal peaks of migration activity.

1.3.3 MARINE AND AQUATIC HABITAT ALTERATION

1.3.3.1 Dredging and Filling

Dredging, the excavation of bottom materials, usually takes place to create and maintain navigation channels, turning basins, and harbors for ships; to excavate pipeline ditches; or to obtain a source material for fill for construction projects. Filling includes the disposal of dredged material resulting in the loss of aquatic habitat and the creation of new land in coastal areas. Dredging and filling can cause a wide range of environmental impacts including 1) the physical destruction of benthic habitat, 2) a temporary increase in turbidity and a decrease in oxygen concentration in the water column, 3) modification of local water circulation and salinity patterns, and 4) direct mortality to organisms swept into the dredge (Hirsch et al. 1978, Starr et al. 1981). These impacts are localized to the site and general vicinity of the dredge and fill project. The impact of a specific dredging project depends on such factors as 1) whether it is a new project or maintenance dredging (new projects usually have greater environmental impacts); 2) method of dredging; 3) the volume and composition of the dredged material; 4) the location of the dredging project and the site-specific environmental conditions including hydrographic conditions, ambient chemical parameters of the water (especially turbidity and oxygen concentrations), and biotic communities; and 5) the method of dredge spoil disposal.

Sensitive Environments and Populations

Highly productive habitats that are susceptible to changes in circulation or drainage patterns, or to the impacts of siltation, are most sensitive to damage from dredge and fill operations. Examples of such habitats include freshwater streams, eelgrass beds, wetlands, tideflats, estuaries, and lagoons. The species most sensitive to the impacts of dredging and filling are those whose life histories are dependent on the above mentioned habitats. They include salmon eggs, fry and alevins rearing in freshwater streams and estuaries, herring spawning in nearshore waters, king crab nursery areas, clam beds, and waterfowl nesting and staging in wetlands. The habitat destruction caused by dredging and filling is most likely to impact a species that is restricted to a relatively small area during a critical life history stage. Examples of such species and habitats include: herring spawning areas, juvenile king crab rearing areas, clam beds, seabird colonies, and marine mammal haul-outs.

Methods of Minimizing Impacts

Methods for minimizing the impacts of dredging include:

- Site activities likely to require dredging where minimal dredging (both initial and maintenance) would be required. Consider alternative gravel sources before allowing gravel to be dredged.

- Avoid dredging in sensitive habitats.
- Operate in a manner that prevents the release and spread of silty bottom sediments with a high biological oxygen demand into the water column. "Silt curtains" and "diapers" may be used to retain sediment laden waters near the dredge site; however, silt curtains are only effective in still waters.
- Clam shell mechanical dredges, rather than hydraulic dredges, should be used in areas which support large populations of commercially or ecologically important marine larvae or juvenile animals that can be entrained or injured in hydraulic pumps and dredge lines.

1.1.3.2 Shoreline Modifications

Structures which change the shoreline are often built as part of harbor and port construction, to control erosion, or to provide new onshore construction sites. Typical shoreline structures include bulkheads, riprap, groins, jetties, breakwaters, causeways, piers, docks, and bridges. Poorly designed and improperly placed structures can destroy important habitat, disrupt nearshore sediment transport and cause unplanned erosion or accretion, and alter tidal circulation. While the effects of individual shoreline modification projects on fish and wildlife may not be significant, a large number of projects can radically alter a natural shoreline.

Breakwaters, groins, jetties and other structures built perpendicular to the coastline can disrupt and inhibit the transport of sediment by wave action and longshore current. The physical properties (e.g., temperature and salinity) of the water, water circulation patterns, and biota in the vicinity of the shoreline structure may be modified by large jetties. Such localized biotic and hydrographic changes have been documented for the Prudhoe Bay Waterflood Project Causeway (Cannon, Envirosphere Company, personal communication). The presence of a shore-connected breakwater that extends to deep water can interrupt the nearshore migration of fish including salmon fry (Starr et al. 1981). Coastal bulkheads and other shoreline structures may result in the loss of adjacent marshes and cut off an important supply of algae, grasses, and detritus to the marine environment. Bulkheads extending below the mean high waterline change circulation patterns and alter adjacent water habitats.

Sensitive Environments and Populations

Impacts of shoreline modification would be greatest in highly productive environments that are susceptible to changes in circulation and longshore sediment transport such as eelgrass, rockweed, and kelp beds, wetlands, tideflats and lagoons. Species most affected by shoreline alteration are those whose critical habitat (such as haul-out areas used by marine mammals and herring spawning areas) would be destroyed by coastal structures or altered by changes in circulation or depth such as nearshore fish migration routes or rearing areas.

Methods of Minimizing Impacts

Methods for minimizing the impacts of shoreline modification include:

- Limit the construction of shoreline structures to situations where no other solution or location is feasible.
- Avoid placing shoreline structures in sensitive habitats including areas where rapid coastal erosion or deposition is occurring.
- Avoid altering natural drainage patterns of shorelands.
- During construction, keep turbidity to a minimum and use turbidity control devices when necessary.
- In appropriate cases, dredging should be done after a bulkhead is installed. The area behind the bulkhead should then be backfilled with the dredged material.
- Bulkheads should be separated from the water with a buffer strip of vegetation, have riprap placed in front of them, and should be designed so that reflected waves do not erode intertidal or subtidal areas. It is usually desirable to drive supporting pilings in for bulkhead construction rather than jetting them in because of reduced siltation impacts. However, in certain

cases (i.e., in important bird nesting areas) the disturbance from pile driving may outweigh the effects of siltation.

- Groins should have their shoreline end above the normal storm-tideline to prevent scouring. They should be designed to avoid both acretion on their upstream side and erosion on their downstream side.
- Jetties should not be built at the mouths of productive anadromous fish streams as resultant changes can affect runs of migratory fish.

1.3.3.3. Flooding and Dewatering

Obstructions to natural drainage patterns usually result in flooding. This can be a beneficial impact of a project if more usable aquatic habitat is created but it also can have detrimental effects when currently existing aquatic habitat is altered. Hydroelectric projects which involve damming rivers often turn river habitat into lake habitat. The species of invertebrates and fish dependent upon swift flowing, shallow, well aerated water found in rivers may not survive in a deep water, slow flowing habitat. River populations may be completely eliminated or displaced further down- or up-stream and there may not be suitable populations in the system which can adjust to the lake environment.

Roads and transportation corridors are often built through wetland areas. If these areas are associated with lakes or streams, the wetlands may provide rearing habitat for grayling or other fish species. Wetlands also function as recharge systems to store and release water to stream and river systems. If waterflow through the wetland is blocked by a road, the upstream side may be flooded while the downstream side is dewatered. In both cases, existing aquatic habitat is altered and may be rendered unusable.

Dewatering of aquatic habitats can also occur as a result of water removal for industrial or residential uses, diversion of streamflow, or floodplain disturbances which alter surface water flow. The construction of low water crossings (fords) with materials that are too permeable can result in stream flow through the gravel rather than on the surface. Extensive disturbance of streambeds from gravel mining operations and installation of pipelines within stream channels may also dewater streams by causing flows to travel along more permeable, subsurface channels. This phenomena is most prevalent during late summer low-flow periods.

Sensitive Environments and Populations

Salmon spawning areas are particularly sensitive to alterations in water level. Dewatering a bed can destroy eggs and alevins already in the gravel and can prevent spawners from reaching previously usable habitat. Flooding of spawning beds can produce higher water velocities which can wash out spawning-sized gravel or destroy eggs and alevins. In the case of a reservoir, salmon may not be able to use the habitat because velocities are too slow to properly aerate the eggs in the gravel. Slow velocities also allow different-sized gravel and other material (bedload) to be deposited, often reducing the usefulness of the habitat.

Fish rearing areas are also sensitive to dewatering. Fish can be stranded in remnant pools or important rearing areas can be dried up completely. Dewatering can prevent fish from moving into feeding zones or from migrating to and from spawning areas. Pumping water from pools under ice can destroy fish overwintering areas.

Methods of Minimizing Impacts

Some general ways of avoiding or minimizing adverse impacts to fish populations due to flooding or dewatering are:

- Avoid construction of hydroelectric dams in areas which would inundate streams containing important fish habitat.
- If roads must be built through wetlands, they must be provided with adequate cross drainage even when defined channels are not present.
- Avoid diversion of water away from streams with usable fish habitat.

- Avoid pumping water from pools under ice.
- Avoid pumping water from lakes, ponds, or streams in volumes that will dewater them.
- Avoid in-stream disturbances such as mining or trenching along floodplains which could alter streambed permeability.

1.3.3.4. Sedimentation

Sedimentation refers to the deposition of fine material on the bed of a stream, lake, wetland, or marine environment. It is differentiated from siltation (Section 1.3.5.2) which is a water quality problem but which may influence sedimentation. All streams experience sedimentation to a certain extent, swift flowing streams less than slower streams. Adverse impacts to biota can occur when sedimentation is increased above ambient sedimentation which occurs in that stream. Sedimentation can result from flattening the stream gradient, thereby reducing the stream velocity and allowing more material in suspension to settle out. It can also result from introduction of more material, particularly silts, clays, and organic matter, to the system. This can occur from gravel mining, dredging, gravel washing, placer mining, pipeline trenching, bridge support excavation, and other similar activities. Removal of vegetation from stream and lake banks can encourage erosion and also introduce fine particles into the water.

Sensitive Environments and Populations

Sedimentation results in the covering of existing streambed substrates and the filling of spaces between bottom materials. Sediment can smother fish food organisms such as algae and invertebrates which cover rocks (ADF&G 1983). Emergent vegetation in wetlands, especially saltwater wetlands, is adversely affected by increased sediment. Fines which filter down into gravel substrates can smother salmonid eggs and young (Hall and McKay 1983). Sessile benthic marine populations such as clams may be adversely affected by sedimentation.

Methods of Minimizing Impacts

Some methods for minimizing impacts from sedimentation are:

- Avoid changing stream gradients or normal stream flows.
- Do not remove bank stabilizing vegetation.
- Screen, filter, or circulated sediment-laden water discharged from mining, pipeline trenching, or other activities through setting ponds before releasing it into waterbodies.
- Use appropriate erosion control procedures to control sediments during in-stream activities.
- Avoid depositing sediments from dredging near important benthic communities including clam beds.

1.3.3.5 Stream Channel Alterations

Stream channel alterations include straightening and shortening channels (channelization), diverting streams, widening or narrowing streams, and changing stream gradients. Channelization is the modification which often receives the most attention. Meandering stream courses are often straightened to accommodate road and/or pipeline alignments. This has the effect of shortening the stream and may increase the water velocity due to an increased stream gradient, i.e., the stream must drop the same amount of elevation but over a shorter distance. The effect of meanders is to absorb the river's energy and allow for the creation of pools and riffles. When a stream is channelized, it in effect creates a water trough; there is usually no opportunity for habitats to form within the channel to replace those that have been lost.

Channelization, gravel mining, or placer mining may make streams shallower by widening the channel. The resulting shallow stream may disappear altogether during dry seasons or low-flow periods. This can have various effects upon the stream biota. Fish may have a more difficult time passing through the shallow waters. Summer water temperatures may increase, adversely affecting fish and invertebrates. Narrowing a channel makes the stream deeper and may increase stream bank erosion and decrease food organism productivity within the channel.

Stream diversions involve moving a stream to another channel or precluding it from utilizing its entire floodplain, i.e., forcing it to one side or the other. Diversions may be temporary or permanent. In either case, stream depth, gradient, and velocity may be changed and fish may be cut off from previously usable feeding, rearing, or spawning habitat.

Stream gradient changes mean making the stream bed flatter or steeper. Gravel and placer mining can affect stream gradients by the addition or removal of streambed materials. Increased gradients cause water to flow faster which may increase streambank erosion and cause downstream impacts. Movement of bedload materials (rocks, sand, gravel) within the watercourse may be altered, creating new areas of deposition and erosion. This attempt by the watercourse to re-establish hydraulic equilibrium can cause changes for significant distances upstream and downstream from the site of disturbance. Salmon spawning beds may be degraded, and increased velocity may also block fish from moving upstream.

Sensitive Environments and Populations

Small, productive, meandering streams are the most sensitive to channel modifications, although all streams are susceptible to adverse impacts from modification. Streams have evolved to a state of equilibrium for gradient, erosion, deposition, and bedload movement. Any change usually causes degradation of habitat with resultant adverse impacts to fish populations (Simpson et al. 1982). Depending upon the specific modifications to a stream, all life stages and species of fish can be affected. Salmon spawning and migration channels are among the most sensitive areas.

Methods for Minimizing Impacts

Some ways of avoiding or minimizing adverse impacts to fish streams due to channelization include:

- Align roads, pipelines, and other facilities so that stream channelization is not necessary.
- If streams must be channelized, the original gradient, depth, and pool/riffle ratio should be maintained.
- After seasonal operations and following termination of placer or gravel mining or similar activities within streams, the stream channel gradient width and depth should be returned to that existing before mining.
- Stream diversions should be avoided wherever possible. Where streams must be diverted, the diversions should be for the minimum time necessary and should have no permanent effects on the natural stream configuration. Diversions should not occur during sensitive life history periods such as fish migration and spawning.

1.3.4 TERRESTRIAL HABITAT ALTERATION

1.3.4.1 Loss of Terrestrial Habitat

Development activities can impact terrestrial habitats by altering their productivity, changing the species composition, or converting the habitat to other uses. The occurrence and productivity of plant communities that comprise terrestrial habitats may be impacted by air pollution, alterations in drainage patterns, removal of vegetative cover, flooding, dewatering, or conversion to other uses.

Subtle alterations of habitats include changes in plant species composition due to dust, drainage patterns, or selective removal (timber harvest of white pine, intensive grazing of preferred forage by caribou or reindeer). More apparent modifications of terrestrial habitat result from extensive clearing, use of herbicides, flooding, or dewatering of saturated soil areas. In some instances, development activities convert terrestrial habitats to other uses by clearing and excavation for mining activity and material sites, covering with foreign materials at waste disposal sites and dredge spoil disposal sites, or covering with gravel for roads, work pads, airstrips, construction camps, ports, support facility pads, oil and gas drilling pads, railbeds, and community facilities. Other large scale development projects in Alaska have shown that the extent of surface disturbance on terrestrial habitats can be quite large, and that even areas used temporarily do not rapidly return to productive terrestrial habitats. Where development projects require extensive quantities of gravel, the loss of habitat from sand and gravel mining may be the principal terrestrial impact of the project (Pamplin 1979). In addition, wildlife may be precluded from using undisturbed habitats adjacent to directly disturbed habitats due to noise or activity which discourages wildlife presence.

Sensitive Environments and Populations

The alteration or loss or terrestrial habitats is most critical to wildlife populations if important feeding areas or seasonal use areas of limited availability are disturbed. The restriction of access to important use areas due to terrestrial habitat alteration is as detrimental to wildlife as direct elimination of the important use area. Sensitive terrestrial habitats include wetlands, important uplands, and riparian areas used by caribou and moose for winter range; discreet spring and fall staging areas in wetlands for waterfowl and shorebirds; rocky shoreline and beach haul-out sites for marine mammals; and wetlands important to waterfowl and shorebirds for nesting, feeding, and molting.

Methods of Minimizing Impacts

Some methods of avoiding terrestrial habitat loss are:

- Avoid siting facilities in important feeding areas and limited availability wildlife use habitats.
- Minimize the size of fills and of cleared areas.
- Revegetate cleared areas with plant species similar to those previously existing. Revegetation should occur as soon as possible after clearing.
- Provide fills with adequate cross-drainage.
- Reduce air pollution which may adversely affect plant productivity.
- Consolidate facility sites, where possible, and consider multiple use and/or sequential use of fill areas for different developments.

1.3.4.2 Erosion

Erosion occurs primarily as a result of vegetative cover removal or cutting banks. It can be hydraulic (water related) or wind generated. During road or pipeline pad construction, banks are cut and fills are built-up to level the grade and reduce curves on the alignment. These cuts may erode during rainfall, at break-up, or as a result of sheet drainage along hillsides. Eroded materials may cover the roadway and/or adjacent terrestrial habitat. Clearing an area may also result in erosion. This often occurs along seismic lines, air strips, and other areas that have been cleared for construction of facilities. Erosion of exposed soil and beaches by wind may occur after clearing or removal of stabilizing vegetation. Shoreline erosion can result from improperly sited shoreline protection facilitites such as groins, breakwaters, and jetties.

Sensitive Environments and Populations

Terrestrial habitats most sensitive to erosion are riparian zones along rivers and streams, and shoreline habitats including beaches and wetlands. These areas are often very productive and are used by a variety of wildlife including birds, small and large mammals, and furbearers. Erosion can reduce the amount of riparian or shoreline habitat available and, therefore, reduce the productivity of the system. Hydraulic erosion of stream banks and fills near wetlands and streams can cause siltation and sedimentation of aquatic habitat for significant distances downstream from the site of disturbance. Erosion can also affect the integrity of development structure fills and transportation systems.

Methods of Minimizing Impacts

Some methods of minimizing or avoiding adverse impacts from erosion are:

- Avoid road cuts or excavations in unstable soils or adjacent to streams.
- Avoid use of fine material for fills.
- Do not concentrate sheet flow into new drainage channels.
- Provide all fills with adequate cross-drainage.
- Use matting over cut slopes to reduce erosion until slopes are revegetated.
- Revegetate all cut slopes and fills immediately upon completion of use.
- Revegetate cleared areas as soon as possible. Minimize the size of cleared areas.
- Site stockpiles and overburden disposal areas where ground is level and away from waterbodies. Sites should not be subject to high water tables or sheetflow, and should be surrounded by berms.
- Use ditch plugs where pipelines are being buried to control erosion along the pipe trench.
- Design all shoreline protection facilities to avoid causing erosion.

1.3.5 WATER POLLUTION

1.3.5.1 Oil Pollution

Oil may be introduced into the aquatic environment in a variety of ways. Oil pollution is classified as either being acute or chronic depending upon its rate of introduction into the environment and the duration of the pollution incident. Acute oil pollution results from a single, relatively large infusion of oil into surrounding waters. Chronic oil pollution results from the continuous or regular discharge of hydrocarbons. While chronic discharges may be less noticeable than major spills, they can potentially introduce more oil to the aquatic and marine environment and cause long term impacts.

Acute oil pollution can result from oil spills that occur during oil exploration and development drilling, production, transportation, or processing. The largest and potentially most damaging spills are associated with oil well blow-outs, ruptures of underwater pipelines, and tanker accidents. Smaller but more frequent spills are associated with oil handling and storage.

Sources of chronic oil pollution can include discharges resulting from activities associated with OCS oil and gas production including discharges from oil production platforms, discharge of formation waters from oil-water separators, and discharges from vessels that are emptying ballast water from their tanks. The latter source of chronic oil pollution could become significant if large crude oil tankers habitually discharge ballast water when returning to oil storage or loading facilities. Chronic oil pollution can also result from small but frequent oil spill incidents in the vicinity of small boat harbors and in streams adjacent to roadways that are oiled to control dust.

The impacts caused by oil depend on a large number of factors including the type and amount of oil spilled, the physiography of the spill area, the season of the year and the weather conditions at the time of the spill, the organisms found in the affected area, previous exposure of the spill area to other pollution events, and the timeliness and effectiveness of clean-up activities. In general, refined oil products are more toxic than crude oil.

Once a spill occurs, it is transported away from the spill site by several mechanisms including water currents and wind. Several physical and chemical processes (i.e., evaporation, microbial and chemical degradation) begin to work on the oil, all of which generally reduce its toxicity. After the aromatic portions of crude oil have evaporated, thick, tarry substances often remain. This tar can coat beaches, riverbanks and rocky shorelines, smothering sessile organisms and fouling recreational sites, boats, docks, and other equipment.

The effects of spilled oil on aquatic organisms can be separated into three levels of effect as follows: 1) short-term lethal effects in which the organisms succumb rapidly; 2) sublethal physiological effects which do not result in the rapid death of the organism but involve major modifications of a variety of physiological processes that may prove lethal over a long period; and 3) behavioral-integrative effects which may not directly involve major physiological disruption, but are reflected in inappropriate behavioral responses to the natural environment.

The method and efficiency of clean-up activities can significantly affect the real impacts caused by a spill. Clean-up technology is fairly well developed for spills that occur during the open water season and on top of shorefast ice. The technology for cleaning up spills during the transition season (broken ice) has yet to be proven. Mechanical clean-up techniques (booms, absorbents, burning) are generally preferable to chemical dispersants that are sometimes used to break-up an oil spill because the potential negative impacts of these chemicals are not fully known.

<u>Sensitive Environments and Populations</u>

Coastal habitats with large concentrations of floating debris are especially vulnerable to oil pollution because physical factors tend to increase the likelihood of oil coming ashore in these locations. Intertidal vegetation such as eelgrass and rockweed can be killed by oil coating. Wetlands and tideflats are highly susceptible to all forms of oil pollution because of their high retention characteristics (Starr et al. 1981).

Studies on the effects of oil on marine mammals are limited. It appears that whales may avoid oil spills but apparently seals and sea otters do not. The toxicity of oil to marine mammals is not well documented although recent studies have shown that some marine mammals exhibit metabolic problems and irritation of mucus membranes after ingesting oil (Starr et al. 1981). In addition oil may cause marine mammal fur to lose its ability to repel water, resulting in an animal's loss of insulation. Sea otters and fur seals may be extremely sensitive to oil contact (Cowles et al. 1981) Areas of marine mammal concentrations such as haul-out areas are sensitive to oil pollution. If adults are contaminated during the time pups are being nursed, the young may ingest oil while nursing. Contact with oil could also inhibit recognition of pups by females and lead to abandonment and starvation of young (Cowles et al. 1981).

The toxicity of oil to individual fish and shellfish species is well documented in laboratory studies, but extensive fish kills after oil spills have not been observed. Sublethal effects are poorly understood but may be more important (Thorsteinson 1984). While there are exceptions, it is possible to make the following generalizations regarding fish, shellfish, and oil. Refined oil is more toxic to fish and shellfish than crude oil. Embryo and larval stages of fish and shellfish are more sensitive to oil pollution than adult stages. Because the eggs and larvae of many species float near the surface of the open ocean, they are particularly susceptible to damage from an open-ocean oil spill (Rice 1981). It is not known if fish can detect and avoid oil spills; however, there is evidence that oil spills in anadromous fish streams can interfere with the homing ability of salmon (Thorsteinson 1984). Among the sublethal effects of oil on fish and shellfish are changes in organ tissues, physiological changes, increased vulnerability to disease, decreased growth, and interference with the reproductive process (Rice 1981; Lewbel 1983).

Birds, i.e., seabirds, waterfowl and shorebirds, are particularly vulnerable to oil spills. When coated with oil, bird feathers lose their insulative qualities and the birds may die of exposure or drown. If the birds attempt to clean their feathers, they may ingest the oil and die from its toxic effects. Birds most sensitive to oil pollution are alcids, especially murres and puffins, and diving ducks such as eiders, scoters, and oldsquaw (Hansen 1981). In many cases the damage inflicted upon a bird colony arises not out of immediate mortalities, but from damage to the reproductive output of the colony. When bird eggs are contaminated with oil their hatchability is reduced, and hatched birds have larger proportions of deformities which ultimately lead to their death. Seabird nesting sites, resting locations, and pelagic feeding areas are all extremely sensitive to oil pollution, as are waterfowl feeding, nesting, molting, and staging areas (Thorsteinson 1984; Starr et al. 1981).

Methods of Minimizing Impacts

General methods for reducing impacts from oil pollution include the following:

- Whenever large quantities of petroleum products are involved, strict operating and safety methods must be employed. Alarm systems and security measures should be developed for all facilities handling oil to prevent spills caused by carelessness, vandalism, or sabotage.
- Hazardous operations with high oil spill risk factors, such as oil well testing and well completions, should be allowed only during periods when the ability to contain and cleanup a spill are maximized.
- During oil well drilling, the operating standards required by the Minerals Management Service should be followed. Depending on the sensitivity of the drill site location and vulnerability of the area to an oil spill incident, a second drilling rig may be required on-site to drill a relief well in the event of an uncontrolled flow of oil due to a blowout or other accident. In less sensitive situations, the availability of a back-up drilling rig within a prescribed time frame may be more appropriate.
- Oil production platforms should be specifically tested to operate safely under conditions of high wind, extreme wave heights, heavy ice, and earthquakes.
- Oil storage facilities should be sited a sufficient distance away from any open water, if possible, and provided with impermeable containment dikes that could contain the contents of the storage facilities in the event of a leak. They should not be located in sensitive habitats, areas of high fish and wildlife concentrations, or in geophysically unstable areas.
- Effluents from oil treatment facilities should be treated to reduce concentrations of aromatic hydrocarbons. Effluents should not contain biologically significant amounts of heavy metals or carcinogenic compounds

that could accumulate in the sediments or the food chain. Effluents should be discharged into marine water areas with sufficient water volume, tidal currents, and water exchange to allow for rapid dilution.

- Pipelines should be consolidated to the maximum extent possible and located away from geophysically active areas. They should be sited to minimize stream crossings and avoid biologically important and sensitive areas. Marine pipelines should be prominantly marked on nautical charts.
- Tanker docks and fueling facilities should be designed with automatic shut off systems and back-up safety systems.
- Oil tankers should be required to meet Coast Guard standards and to have "load on top" or segregated ballast tanks. The discharge of ballast or bilge waters in sensitive marine waters should be prohibited.
- Effective oil spill containment and cleanup plans should be prepared and containment and cleanup equipment should be stationed in the region. Trained personnel should be available at all times to operate the equipment. Anchor points for oil exclusion booms should be identified at the mouths of all important fish streams, lagoons, and bays. Only approved chemical dispersants should be used to protect species and habitats sensitive to the physical effects of oil pollution.

1.3.5.2 Siltation

Siltation (turbidity) is the addition of suspended solids to freshwater and marine aquatic systems. Excessive turbidity above naturally-occurring levels or at times of the year when aquatic systems are generally clear can adversely affect overall stream or marine environment productivity. Siltation also has an adverse effect on the visual appearance of aquatic systems used for recreational purposes and can make water used for human consumption unpalatable.

Both the quantity and quality of light penetrating the water surface is affected by suspended sediment loads. In extremely turbid waters, the light at a depth of one meter may be reduced to less than one percent of the light incident at the surface. When turbidity levels are very high (over 25 Jackson Turbidity

Units), stream productivity begins to decline rapidly. Plants utilize specific wavelengths of light for photosynthesis. Short wavelengths which are filtered out by suspended sediment are especially important. Hence, the filtering effect of siltation can diminish the photosynthesizing abilities of plants, ultimately reducing the productivity of the entire aquatic system (Hall and McKay 1983).

Turbid water can result in an increase in stream temperature. The suspended particles in turbid water absorb more radiation from the sun than clear water, initiating changes in stream temperature that can affect the dissolved oxygen content and subsequently the ability of the stream to support fish.

Sensitive Environments and Populations

Siltation of freshwater and marine aquatic systems is potentially most detrimental in productive habitats which support spawning, rearing, and feeding fish and shellfish. Effects of increased sediment loads on fish and shellfish include interference with respiration and reduced visibility which can interfere with feeding activities. In addition, salmon may avoid turbid spawning areas (Lewbel 1983). Even where fish resources are not directly impacted by siltation, the associated impacts of reduced photosynthesis, increased water temperature, and reduced dissolved oxygen can decrease the value of aquatic systems to fish.

Freshwater streams which provide spawning and rearing habitat for anadromous fish are sensitive to the impacts of siltation. Estuaries, barrier island lagoons, and offshore waters adjacent to the shoreline are generally the most productive marine waters which could be impacted by the effects of siltation. These waters support high levels of photosynthetic activity and feeding activity by juvenile fish and waterbird species.

Methods of Minimizing Impacts

Some methods for minimizing impacts to aquatic systems from siltation are:

- Select facility sites that minimize potential erosion and introduction of suspended sediments to aquatic systems.
- Avoid discharge of turbid waters to sensitive aquatic habitats, particularly during periods when the background level of siltation is low.
- Avoid discharge of turbid waters to aquatic systems during sensitive life history activities of fish such as spawning, overwintering, and incubation of eggs.
- Onshore discharge of turbid waters should utilize stable upland areas for filtering and infiltration in preference to direct discharge to rivers, lakes, wetlands, and estuaries.

1.3.5.3 Sewage

The term "sewage" denotes human and household wastes. It is necessary in any human settlement to dispose of waste materials. Discharging sewage directly to river, lakes, streams, or the ocean can result in a number of problems, including contamination of domestic water supplies and food with disease organisms. Fish and invertebrates consumed by man can be contaminated with pathogens (bacteria or viruses which cause diseases) especially if the water to which the sewage is discharged does not carry the waste away from the discharge point or sufficiently dilute it. Poorly designed septic systems can also cause drinking water to be contaminated.

Sewage loading in closed systems such as ponds and lakes can cause an increase in oxygen demand in the water. Dissolved oxygen at the lower levels of the lake is depleted, killing plants and animals dependent upon oxygen. If the water of the lake is mixed by winds or temperature inversions, the anaerobic (oxygenless) water becomes distributed throughout the water-body killing all aquatic life within it. Massive fish kills can result from this situation. Noxious blooms of algae and bacteria can also occur when sewage is loaded into water bodies. Some of these organisms may produce toxins harmful to man and animals.

Sensitive Environments and Populations

Ponds, lakes, wetlands, and enclosed lagoons are more sensitive to pollution from sewage than are swift-flowing streams and the open ocean. Man is one of the most sensitive organisms to this type of pollution because of disease transmittal. Fish such as salmon and trout, which are adapted to clean, cold waters, are also sensitive to a reduction in water quality.

Most water pollution from sewage can be avoided by installing properly designed septic systems or sewage treatment facilities. In Alaska, proper water quality can often be maintained with primary treatment only and chlorination of wastewater; in some situations, secondary treatment may be required.

Methods of Minimizing Impacts

Some methods of avoiding or minimizing adverse impacts from introduction of sewage to waterbodies are:

- Raw (untreated) sewage should not be discharged to any waterbody or onto the land.
- Discharge sewage where maximum dilution will be achieved.
- Septic systems should be properly sited and constructed so that domestic water supplies are not contaminated.

1.3.5.4 Seafood Processing Wastes

Seafood processing wastes are introduced into coastal waters by both onshore and offshore seafood processing plants. In remote locations such as the Aleutians East CRSA, seafood wastes consisting of ground fish and shellfish, and processing water receive no treatment prior to discharge.

Seafood wastes have high organic, nutrient, suspended solid, and oil and grease concentrations. They can cause low oxygen and high nutrient (especially nitrogen) concentrations in the receiving waters and a grease slick on the water surface. Seafood waste can also accumulate on bottom sediments if discharges exceed the capacity of the receiving water to disperse the waste.

The extent of potential impacts caused by seafood wastes is primarily determined by the amount of waste, the location of the discharge outfall and the physical, chemical and biological characteristics of the receiving waters and sediments (Karna 1978). When outfalls are submerged below lower low water and are situated in locations with strong tidal currents where wastes are quickly dispersed, the impacts are minimized (NOAA 1980). If wastes accumulate because of restricted bottom circulation, the deposits can smother benthic organisms and alter adjacent bottom communities. In extreme cases sediments may become anoxic (depleted of oxygen). Impacts from seafood waste disposal are usually localized to small areas (Feder and Burrell 1982).

A variety of organisms including birds, pelagic fish such as Dolly Varden and herring, and crabs are sometimes attracted to the vicinity of seafood waste outfalls to feed on particles of fish and shellfish tissue (Fisheries Research Institute 1971).

Sensitive Environments and Populations

Coastal habitats that have restricted water circulation such as lagoons and some poorly flushed estuaries are most sensitive to the impacts of seafood waste disposal. Sessile benthic organisms such as clams are most vulnerable to impact from accumulated deposits resulting from seafood waste disposal.

Methods of Minimizing Impacts

The most effective methods for minimizing impacts from seafood waste disposal are:

- Site discharge outfalls below lower low water in areas with strong tidal currents so that wastes are quickly dispersed and do not accumulate.
- Locate discharge areas away from important benthic resources such as clam beds.
- Avoid siting of multiple processing plants on the same bay or estuary.

1.3.5.5 Heavy Metals/Toxic Substances

Heavy metals and toxic substances introduced into or transported by aquatic systems can detrimentally affect water quality for biological organisms and render the waters unsuitable for other uses (i.e., drinking water). Heavy metals and toxic substances can occur naturally in aquatic systems or they may be introduced as a result of development activities.

Of the 59 heavy metals present in the earth's crust, 17 are considered toxic to biological communities. In Alaska, silver, cadmium, lead, nickel, copper, zinc, selenuim, mercury, arsenic, and chromium have been shown to be bioaccumulative (may concentrate in biological tissues) with subsequent impacts to the living organism (Metsker 1982). Heavy metals that can be introduced to aquatic environments as a result of surface disturbing activities such as mining or from ore processing include iron, cadmium, tin, antimony, aluminum, manganese, mercury, arsenic, and selenium. The toxicity of these metals is determined by the form in which they are released. Sodium, calcium, and magnesium are generally discharged as salts, buffering their toxic effects; however, sulfates released along with buffered metals have been reported to increase the toxicity of several of the more common heavy metals. The toxicity of copper, lead, zinc, and nickel may even be increased by sea water conditions (Metsker 1982).

Heavy metals incorporated into sediments are not readily removed from aquatic systems. Benthic organisms that ingest sediments may concentrate heavy metals in their tissues. Bottom-feeding fish generally contain higher concentrations of heavy metals than pelagic feeders, although pelagic biota can be affected if toxic materials are transferred from the sediments to the water column (Metsker 1982). Acid water conditions and high concentrations of trace metals in excess of 500 ppm are known to inhibit decomposition of organic matter, subsequently affecting nutrient cycling.

The surface film of water bodies can concentrate both heavy metals and organic pollutants at a level greater than the lower water column. Metsker (1982) reported that recent studies have shown that soluble lead, vanadium, cadmium, copper, zinc, and nickel can accumulate in sufficient quantities to inhibit the production of aquatic organisms. Heavy metals concentrated within the water surface film can detrimentally impact surface-inhabiting organisms such as fish eggs and crustacean larvae.

Drilling muds and cuttings associated with oil and gas exploration and development in freshwater and marine environments are often discharged to aquatic systems at the completion of use. Drilling muds are comprised of clay, water (or oil), and chemicals. These fluids and their chemical components may at times be acutely toxic to fish and marine invertebrates (Starr et al. 1981). The most commonly used components of water-based muds are barite, caustic soda, bentonite clays, and lignosulfonates. Ferrochrome lignosulfonate, a heavy metal compound, may be freed by chemical reactions when released into the marine environment (Starr et al. 1981). Some drilling muds contain additives (caustic soda, preservatives, viscosifiers, emulsifiers, completion chemicals, and thinners) which may be acutely toxic to fish and aquatic invertebrates. Even though the chemical components of drilling muds may not be present in toxic concentrations in aquatic waters, heavy metals present could accumulate to toxic levels in animal tissues.

The presence of heavy metals in aquatic systems can adversely affect fish by interfering with the functioning of the gills and/or the formation of insoluble compounds with the mucus present in fishes' skin, mouth, and gills. The resulting disruption of respiratory and circulatory processes, waste removal, and salt balance can lead to death (Metsker 1982). Heavy metals can also accumulate in fish tissues causing internal body function disorders. The recognized effects of heavy metals on fish include disruption of migration, skin and eye disorders, reproduction failure, neurological disorders, changes in behavior, stress responses, lowered disease tolerance, interference with physiological processes, and death.

Heavy metal contamination can potentially affect living organisms or ecosystems by 1) changing the species composition in the area where the effluent is discharged, 2) disrupting the biological systems of individual organisms, and 3) accumulating to toxic levels in higher trophic levels of the food chain (Starr et al. 1981).

Sensitive Environments and Populations

Benthic (bottom-living) aquatic organisms that ingest sediments during feeding may concentrate toxic levels of heavy metals. Chironomids are among the most sensitive species (Metsker 1982). Bottom-feeding fish are generally most vulnerable to the accumulation of toxic levels of heavy metals due to their feeding habitats. Biological organisms higher in the food chain (seabirds, waterfowl, and seals) can be affected by the toxicity of heavy metals if their principal food sources have been contaminated.

Aquatic habitats with restricted circulation such as bays, estuaries, lagoons, lakes, and ponds are probably most sensitive to the introduction of heavy metals due to the limited flushing action, presence of sediments, and heavy use by fish, birds, and marine mammals for feeding.

Methods of Minimizing Impacts

Preventative methods for minimizing impacts from heavy metals and toxic substances in aquatic systems are:

- Avoid discharge to aquatic environments of effluents, surface drainage, or processing waters containing heavy metals and toxic substances.
- Wherever possible, drilling muds should be retained and used for drilling other wells.
- Drilling muds with heavy metals or toxic additives should not be discharged to the aquatic environment.

1.3.6 AIR POLLUTION

Air pollution can occur from a variety of development activities involving combustion of fossil fuels (oil, gas, coal), power generation, mining and surface-disturbing activities, and processing and extraction operations. Sources of air pollution include heavy equipment, electric power generation from fossil fuels, vehicles, storage and processing of oil and gas, marine tankers, liquified natural gas (LNG) plants, petrochemical plants, refineries, mineral extraction and smelting, flaring, heavy aircraft traffic, and dust resulting from construction or wind-induced erosion. Airborne emissions of pollutants that can affect vegetation and health of humans include sulfur dioxide, carbon monoxide, oxides of nitrogen, hydrocarbons, heavy metals, particulates, and secondary products such as acid rainfall (Malhotra and Blauel 1980). Vaporized hydrocarbons, such as LNG, may be emitted into the atmosphere at transfer points (i.e., marine terminals, LNG plants, fuel storage tanks, leaks from pipelines, valves, and seals).

The type and amount of emissions produced is dependent on the function of the facility or emission source, the type of fuel combustion, the manufacturing or extraction process, the type of pollution control equipment in use, the ambient air conditions of the site, and the local meteorological conditions. The exhaust from fuel-fired facilities and machinery used in construction, mining, and power generation activities can release nitrogen oxide from diesel-powered equipment and carbon monoxide from gasoline powered equipment. Sulfur dioxide may be released from the combustion of high sulfur fuels (marine tankers, power generation facilities), the processing and refining of natural gas and petroleum products, and the intermittent release of sulfur dioxide from emergency flaring, equipment malfunctions, and oil and gas blow-outs that ignite (Malhotra and Blauel 1980). Construction or production activities which expose the soil surface or subject it to heavy traffic can generate excessive dust. Rock-crushing operations for production of select gravel materials are also a source of fugitive dust pollution.

Sensitive Environments and Populations

Air-borne pollutants can affect the health of humans and the vigor and composition of vegetation communities. For humans, some pollutants interfere with nervous system functions, cause eye and respiratory irritation, may cause lung cancer, or are suspected of being carcinogenic (Starr et al. 1981). The sensitivity of plants to pollutants is dependent upon 1) their genetic make-up; 2) their age, health, vigor, and state of metabolic conditions (growing season or dormant); and 3) the type and rate of pollutant uptake and accumulation. High concentrations of pollutants often produce immediate and acute impacts with readily recognizable symptoms, while low concentrations may produce subtle effects that are not easily identifiable. Since some species of plants may be more vulnerable to certain pollutants or combinations of pollutants, they may be eliminated from the vegetation community in the area of pollution impact.

Atmospheric conditions can also interact with the presence of certain pollutants to produce acidic rainfall which can detrimentally impact plant and animal communities. Dust generated by heavy traffic on unpaved roads or extensive surface-disturbing activities can affect the vigor of vegetation in the downwind plume by reducing the efficiency of photosynthetic activities during the growing season and inducing an earlier smowmelt in the dust zone along the roadway. This premature melt-off is caused by large amounts of dust which settle on the snow and absorb thermal energy from the sun. The premature melting of snowcover may attract migratory waterfowl, birds, and grazing mammals such as caribou to the exposed areas; this attraction to snow-free areas along the roadway dust plume has occurred along the Dalton Highway to Prudhoe Bay since construction of the Trans-Alaska Oil Pipeline (Hanson, personal communication; McCaffery et al. 1982). The attraction could subject wildlife to increased predation, premature nesting, and altered migratory patterns.

Methods of Minimizing Impacts

Some methods of minimizing or avoiding adverse impacts from air pollution are:

- Equip vehicles and construction machinery with appropriate emission control devices.
- Take appropriate measures to reduce fugitive dust from construction operations, roadway traffic, and gravel crushing operations.
- Equip power generation and stationary processing facilities with appropriate pollution control devices.
- Give adequate consideration to ambient air quality and meteorological conditions to insure dispersion of pollutants when selecting sites for facilities which may generate pollutants.

1.3.7 HUMAN/ANIMAL INTERACTIONS

In much of Alaska, development occurs in remote areas where animal populations have been relatively undisturbed by man. Human presence in these areas can result in animal/human conflicts. Harressment of animals is one form of conflict. Airplane pilots may deliberately haze animals, causing them to run to escape. In addition to the physiological stress this causes to wildlife, injuries may be caused in rough terrain or to young animals. All-terrain vehicles and "three-wheelers" may also be used to harrass animals.

Animals often are attracted to easily available food sources near human settlements and construction camps (Milke 1977). Bears and foxes quickly become acclimated to foods from garbage dumps, especially if putrescibles are not incinerated. Construction workers may exacerbate the problem by feeding animals (Milke 1977, Hanley et al. 1980, Follmann and Hechtel 1983). During construction of the Trans-Alaska oil pipeline, bears, wolves, and foxes became accustomed to and dependent on garbage and handouts of food by workers. These animals lost their fear of man and accosted persons in vehicles, wandered in and out of camps seeking food, and waited along roadsides for handouts. Vehicles and camp buildings sustained expensive damage and incidents between wildlife and humans were common.

Concentrating animals into groups, especially around potential food sources like garbage dumps, facilitates the spread of disease. Some diseases such as rabies can be transmitted to man. The presence of artificial food sources also interferes with the normal activities of animals. Bears may linger near camps later than normal in the fall before denning, or become totally dependent on unnatural foods.

Sensitive Environments and Populations

Wildlife concentration areas which provide denning, calving, nesting, spawning, and overwintering habitats are areas with high potential for animal/human interaction. Caribou and moose calving areas are particularly sensitive to harrasment. High use areas for brown bears such as seasonal concentration areas along the coast or fish streams are particularly vulnerable to the creation of attractive nuisance situations.

Methods of Minimizing Impacts

Some general ways of avoiding or minimizing adverse impacts from human/animal interactions are:

- Camps and other facilities should be sited away from areas of known animal concentration.

- All camp dumps and other facilities should be fenced to preclude animals from entering.
- Buildings should be skirted to keep animals away.
- All putrescible wastes should be incinerated in an approved waste disposal site.
- Food should be placed in secured containers and should not be an "attractive nuisance."
- Workers should be thoroughly briefed on animal behavior and should be kept from harrassing animals or from feeding them.
- Abnormal behavior among animals should be reported to the Alaska Department of Fish and Game.

1.3.8 CULTURAL IMPACTS

Increased development in remote areas usually means increased populations, either temporarily or permanently. Communities may be changed by the influx of people from outside the area. People with different values and beliefs may move into the area. All of these things can have an unsettling effect upon a community and conflicts can arise between different groups. If the development infuses the community with people and money for only a limited amount of time, readjustment to former lifestyles and population levels may be difficult when transients leave.

Sensitive Environments and Populations

Small villages in remote areas with essentially homogeneous populations may be more sensitive to economic and ethnic changes. In areas where a subsistence lifestyle predominates, the change to a cash economy may be difficult, as would be the change back after there no longer is a source of cash.

Methods of Minimizing Impacts

Some ways of minimizing adverse cultural impacts which may occur as a result of increased development include the following:

- Time development activities so that impacts resulting from large influxes of people are coordinated with local community desires.
- Coordinate the location of camps and support facilities with local community objectives; the use of enclaves away from existing communities may be desirable.
- Work with communities well in advance of development to help prepare them for results of increased population.

1.3.9 IMPACTS ON COMMUNITY INFRASTRUCTURE

Large development projects often result in a large influx of people to areas which do not have the infrastructure to accommodate the demands of the increased population. Transportation by road, air, and sea may be needed. Communication systems may be required as well as more health services and, if workers are accompanied by families, more education and housing facilities. Communities may be hard-pressed to respond to these demands.

In some cases, the population of the community may be increased only temporarily and may then drop back to near pre-development levels during operation of the development or after development is terminated. If the community infrastructure has been expanded to meet the increased demands, the community could be left with unneeded and expensive facilities. In other cases, the fact that infrastructure now exists in the community may attract people who will remain after the development ceases. Other industries may become interested in the community if goods and services are available.

Sensitive Environments and Populations

Small, remote settlements suddenly faced with large numbers of persons moving into the area are the most sensitive to impacts on infrastructure. If development of an area is a possibility, the industry should work with the community to develop appropriate infrastructure before the need becomes critical.

Methods of Minimizing Impacts

Some methods of minimizing impacts to community infrastructure are:

- Time development activities so that impacts resulting from large influxes of people are coordinated with local community desires.
- Coordinate the location of camps and support facilities with local community objectives; the use of enclaves away from existing communities may be desirable.
- Work with communities well in advance of development to help prepare them for results of increased population.
- Design camps and other facilities so that they can be removed after completion of use or converted to other functions.

1.3.10 VISUAL AND AESTHETIC IMPACTS

Many development activities can have impacts on visual/aesthetic resources. Wind generators, offshore drilling platforms, oil wells, and other industrial developments are often considered to have impacts on scenic vistas (Nassauer 1983). Roads, gravel pits, seismic lines, survey lines, transmission lines, open pit mines, and placer mining disposal piles are also often thought to have negative visual qualities. Most developments can avoid aesthetic problems through adequate preplanning.

Sensitive Environments and Populations

Visual impacts are considered more serious in areas near existing communities or recreation areas. Coastal promontories, mountain ridges, high mountain peaks, and scenic vistas are most sensitive to visual and aesthetic impacts.

Methods of Minimizing Impacts

Some ways of avoiding adverse visual/aesthetic impacts are:

- Site gravel pits and mines away from communities and other vantage points.
- Roads to gravel pits, pump stations, and other developments should be built with a "dog leg" alignment to minimize the visual impact of the development from intersecting roads.
- Developments should be removed and disturbed sites revegetated after completion of use. When facilities are no longer needed, sites should be restored by removing buildings, blocking roads, and regrading and revegetating sites.

1.3.11 DISTURBANCE OF HISTORICAL AND ARCHEOLOGICAL SITES

Historic and archeological sites can be disturbed or destroyed by construction and excavation activities. Once a site is disturbed its value is often lost. This is especially true of archeological sites. Therefore, it is extremely important that these sites be located, and if deemed desirable, professionally evaluated prior to site disturbance. In some cases historic structures can be moved to avoid damage from construction activities.

Sensitive Environments and Populations

There are both state and federal laws that protect recognized historic and archeological sites. Sites that are not known or listed on official registers and are discovered during other land use activities such as construction or mining are most sensitive to disturbance. Such sites can be disturbed, and inadvertently destroyed before their importance is recognized and evaluated.

Methods of Minimizing Impacts

Physical disturbances to historic and archeological sites can be minimized through thorough pre-project surveys, familiarity with locations of identified sites, and avoidance of important sites. If historical or archeological sites are discovered during development activities, potentially damaging action should cease until the site can be evaluated and/or protected.

1.3.12 DISRUPTION OF COMMERCIAL FISHING ACTIVITIES

A variety of developments can disrupt commercial fishing operations. The specific activities which can impact fish populations and habitat have been addressed in appropriate impact discussions of this analysis. This Section highlights developments which have the greatest potential for conflict with existing commercial fishing activities. The principal developments of concern are oil and gas exploration and production, mining, and development of new commercial fisheries.

1.3.12.1 Pre-emption of Fishing Grounds

Fishing grounds can be adversely affected by siting offshore drilling rigs and platforms, offshore loading facilities, and/or pipelines on them as well as by increased quantities of debris on the seafloor. Fishing is usually prohibited within a certain distance of each facility (called a safety zone), although rules may be different for different gear types. For example, trawling may be prohibited over a submarine pipeline but gillnetting allowed. Debris from offshore construction activities and facilities can effectively preclude fishing in an area because fishermen will not want to risk damaging their gear on snags

(Wybrow, unpublished). An oil spill can also temporarily make a fishing area unusable as fishermen are unlikely to enter the oiled area for fear of fouling their gear or contaminating their catch. Seismic surveys may make fishing very difficult within a particular location, but the pre-emption is temporary. The extent of long term losses of fishing grounds depends on the location, number, and size of offshore structures and safety zones. The timing of temporary fishing ground pre-emptions is central to determining their impact; i.e., if an important fishing ground is pre-empted during the peak of a short fishing season, the economic impacts would be most severe (Thorsteinson 1984).

Sensitive Environments and Populations

Fisheries most sensitive to a pre-emption of the grounds are those where prime harvest areas are limited and seasons are short such as herring, salmon, halibut, and crab fisheries. Trawl fisheries which utilize large but discrete sections of the ocean bottom are especially sensitive to loss of access to the seabed.

Methods of Minimizing Impacts

Methods for minimizing the impacts of OCS oil facilities and activities on fishing grounds include:

- Encourage early and substantive communication between commercial fishing representatives and other marine resource users.
- Site structures away from important fishing grounds.
- Time seismic activities to occur during periods other than fishing seasons.
- Prohibit the disposal of debris on the seabed.

1.3.12.2 Gear Loss or Damage

Oil and gas activities have the potential to damage or cause the loss of fishing gear. Trawl gear could be fouled on seafloor wellhead completions, pipelines, exposed wellheads, drill rig or production platform mooring chains, or large pieces of debris left on the seafloor. Gear snags in debris have been the most common cause of gear damage in the North Sea (Wybrow unpublished). Seismic vessels and OCS oil and gas support vessels could overrun commercial fishing set gear and sever the marker bouy, making gear recovery impossible. This risk is especially great at night or during periods of low visibility. Oil from a spill could coat gear, necessitating an expensive cleaning operation or requiring replacement of the gear. One type of fishery can also damage the gear of another fishery. For example trawl gear can sever buoy lines that mark crab pot and longline locations, making it impossible to recover the gear.

Sensitive Environments and Populations

Trawl fisheries (groundfish) are most sensitive to gear damage and loss from snags. Fisheries that use stationary gear such as longlines (halibut, cod, sablefish) and pots (crab) would be most susceptible to gear loss from vessel traffic and seismic testing.

Methods of Minimizing Impacts

Methods for impact minimization include the following:

- Have all potential obstructions to fishing communicated to fishermen in a timely manner.
- Minimize the amount of debris on the seafloor.
- Communicate seismic survey plans to fishermen.
- If an oil spill occurs, keep fishermen informed on the location of oil slicks near fishing grounds.
- Temporally and/or geographically separate fisheries with conflicting gear types.

1.3.12.3 Tainting

Fish and shellfish can be tainted by coming into contact with crude oil and refined oil products. Food that is tainted may have concentrations of petroleum far below toxic levels, but has "off" flavors or aromas, and consequently is unsaleable. There are a wide variety of volatile components present in petroleum that can cause tainting. Generally people are most sensitive to phenol and sulfur compounds; thus minor components of a petroleum substance may be a major contributor to its tendency to taint food. Tainting can occur either through the ingestion of petroleum by the fish or by direct absorption of petroleum from the water or oil-coated fishing gear through the gills or skin. Once organisms are tainted, the off odor is not readily lost (Connell and Miller 1981). In addition to actual tainting of product, an oil spill may result in the problem of "perceived tainting", i.e., the fish product is perfectly satisfactory, but buyers and consumers think it may be tainted and avoid purchase of the product (Thorsteinson 1984).

Sensitive Environments and Populations

Since pelagic fish such as salmon and herring are most likely to come into contact with spilled oil, these fisheries are highly sensitive to tainting. In addition, "at sea" processors or crabbing vessels with live tanks that require circulating seawater intake and circulation could take in oil-contaminated waters and hence are sensitive to tainting.

Methods of Minimizing Impacts

The only ways to avoid tainting are for fishermen to avoid using fouled gear and to avoid taking fish that are in or have passed through oiled areas.

1.4 ADDITIONAL INFORMATION ON IMPACTS

The impact descriptions and methods of minimizing impact included in Section 1.3 are brief summaries that highlight only the most important information. Section 1.4 provides the interested reader with a guide to documents with more extensive information on particular developments and their environmental impacts.

Additional information on activities and impacts associated with OCS oil and gas exploration and development, along with suggested methods for reducing impacts can be found in an excellent report by the Alaska Department of Fish and Game, "Recommendations for Minimizing the Impacts for Hydrocarbon Development on the Fish, Wildlife, and Aquatic Plant Resources of the Northern Bering Sea and Norton Sound" (Starr et al. 1981). While the report contains information specific to the Norton Sound Region, its findings are generally applicable to similar activities in the Aleutians East CRSA. Detailed information on potential conflicts between the fishing and petroleum industries in the Aleutains East CRSA can be found in "St. George Basin and North Aleutian Shelf Commercial Fishing Industry Analysis" (Earl L. Combs, Inc. 1981). Fishing - petroleum industry conflicts in the Bering Sea are discussed in Minerals Management Service report entitled "Bering Sea Commercial Fishing Industry Impact Analysis" (Centaur et al. 1984). Procedures for minimizing conflicts between these two industries during offshore geophysical surveys have been developed by Representatives of the Fishing and Petroleum Industries in "A Manual for Geophysical Operations in Fishing Areas of Alaska" (1983).

Guidelines for minimizing the impacts of removing gravel from Arctic and Subarctic floodplains have been developed for the U.S. Fish and Wildlife Service in "Gravel Removal Guidelines Manual for Arctic and Subarctic Floodplains" (Woodward Clyde Consultants 1980) and are generally applicable to the Aleutians East CRSA. Other appropriate references include "Fisheries Handbook of Engineering Requirements and Ecological Criteria" by Milo C. Bell (1973); "Natural Resource Protection and Petroleum Development in Alaska" (USFWS

1981); "A Handbook for Management of Oil and Gas Activities on Lands in Alaska" (Hanley et al. 1983); and "Bering Sea Biology" by Lewbel (1983).

Information on site specific resource concerns and in-depth treatment of potential impacts can also be found in government agency and industry reports and Environmental Impact Statements (EIS) including: the St. George Basin Environmental Impact Statement for Proposed Oil and Gas Lease Sale 70 (Alaska Outer Continental Shelf Office 1981); Outer Continental Shelf Exploration Plans, Environmental Reports, and Oil Spill Contingency Plans; the proposed Bristol Bay Cooperative Management Plan and Revised Draft Environmental Impact Statement (1984); and the Proceedings of a Synthesis Meeting - The North Aleutian Shelf Environment and Possible Consequences of Planned Offshore Oil and Gas Development (Thorsteinson 1984).

SECTION 2.0: POTENTIAL DEVELOPMENTS IN THE ALEUTIANS EAST CRSA.

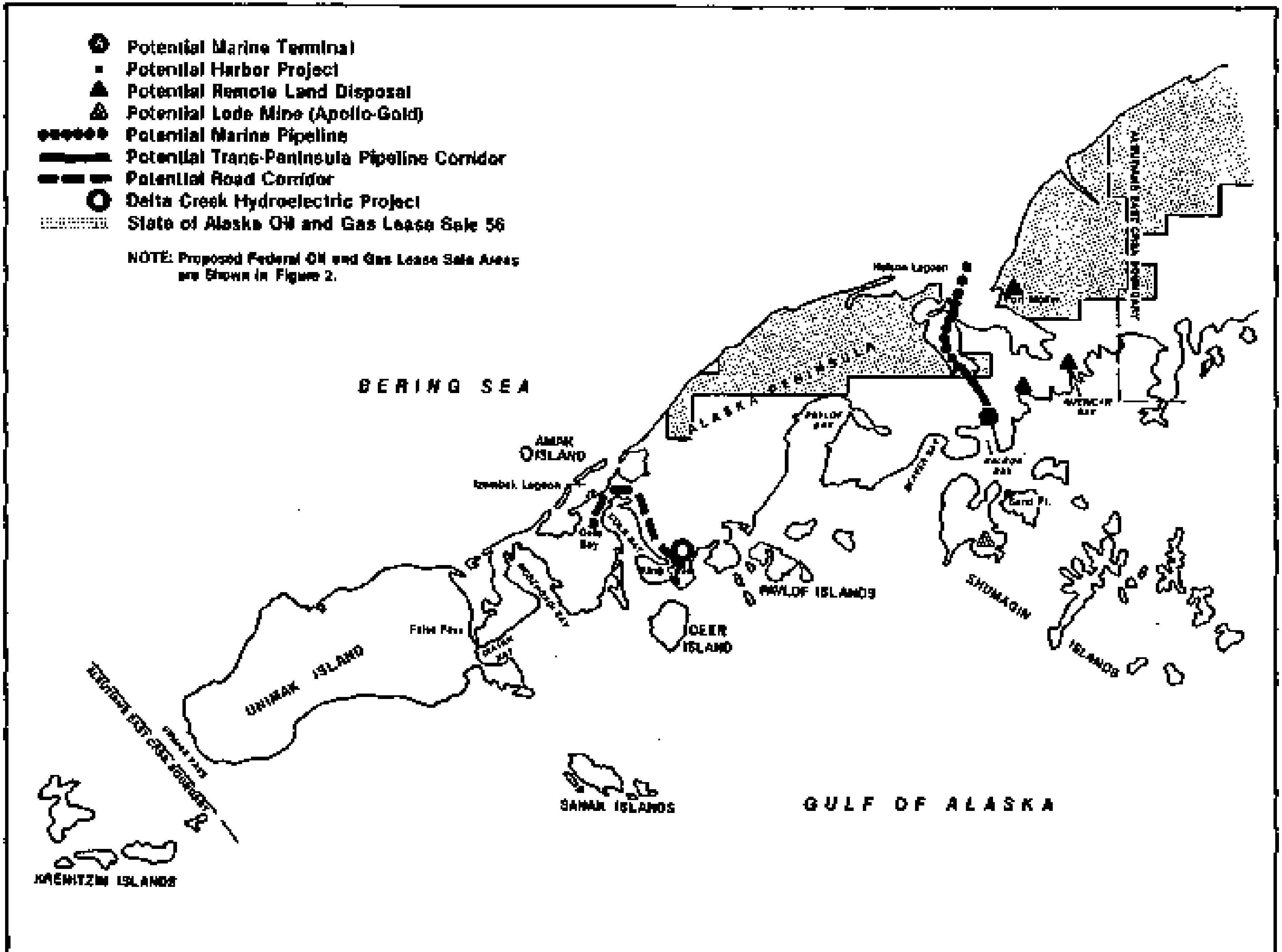
2.1 POTENTIAL DEVELOPMENTS AND SENSITIVE RESOURCES

The general locations of the potential developments in the Aleutians East CRSA described in the following sections are illustrated in Figure 1. Information about each development is summarized and, where sufficient detail is available, potentially sensitive resources are mapped and briefly discussed. It should be emphasized that most potential developments are resource related; however, the extent of the resources are not yet known and the economic feasibility of their development has not yet been determined. Consequently, most of the developments discussed are are somewhat speculative and based on best available information as obtained from interviews and the proposed Bristol Bay Cooperative Management Plan. Detailed impact analyses cannot be prepared until the specific timing and details of a project are known.

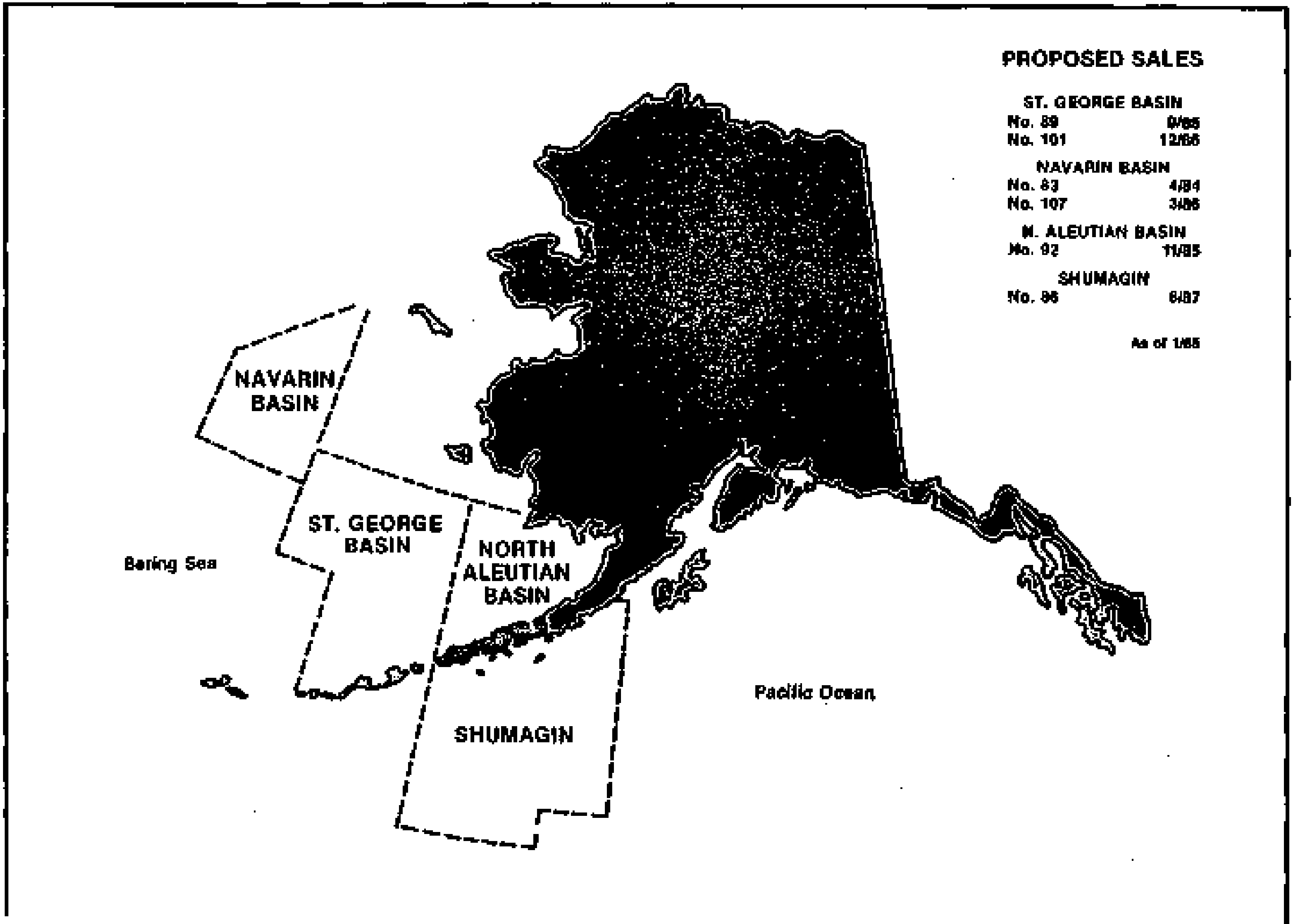
2.1.1 OUTER CONTINENTAL SHELF OIL AND GAS

Outer continental shelf (OCS) oil and gas development in both the Bering Sea and Gulf of Alaska over the next two decades has the potential to significantly impact the people and resources of the Aleutians East CRSA. A federal lease sale (No. 70) took place in the St. George Basin area in 1983 and additional sales are currently scheduled for the St. George Basin, North Aleutian Basin, Navarin Basin, and Shumagin areas. The general location and schedule for these sales is illustrated on Figure 2. It is highly unlikely that natural gas discoveries in the Bering Sea can be economically developed in the near future.

Development scenarios and a summary of current information about each proposed sale is presented below. It must be emphasized that this information is tentative. Lease schedules and tract offerings often change, and all estimates of potential oil reserves are speculative. Pre-sale development scenarios are hypothetical and are best used as illustrations of the types of activities that may occur rather than as input for specific planning activities. The actual timing, magnitude, and duration of oil and gas exploration and development activities



POTENTIAL DEVELOPMENTS IN THE ALEUTIANS EAST CRSA


PROPOSED SALES
ST. GEORGE BASIN
No. 89 9/85
No. 101 12/86
NAVARIN BASIN
No. 83 4/84
No. 107 3/86
N. ALEUTIAN BASIN
No. 92 11/85
SHUMAGIN
No. 86 6/87
As of 1/85
NAVARIN BASIN
ST. GEORGE BASIN
NORTH ALEUTIAN BASIN
SHUMAGIN
Bering Sea
Pacific Ocean

depend on many factors including the availability of capital, labor and equipment, the policies of state and local governments, and the amount, location, and commercial viability of the petroleum resource.

While all OCS lease sale areas are outside the boundaries of the Aleutians East CRSA, onshore and offshore activities associated with OCS oil exploration and production which may directly impact the region include the following:

- Cold Bay has been identified as the probable air support center for exploration and development activities that occur in the St. George and North Aleutian Basin lease areas.
- Production and shipment of oil from any offshore field in either the Bering Sea or Chukchi Sea will result in increased tanker traffic through Unimak Pass.
- Several development scenarios generated by the Minerals Management Service (MMS) for oil development in the Bering Sea call for the use of ice-reinforced shuttle tankers to bring oil from the production area through Unimak Pass to a marine terminal for supertankers (Very Large Crude Carriers, VLCC) located in a remote site on the south side of the Alaska Peninsula (Balboa Bay is the site most frequently mentioned).
- Oil spills originating offshore within the Bering Sea sale areas may come onshore in the Aleutians East CRSA and/or impact resources that are of economic importance to Aleutians East CRSA residents.

St. George Basin

Sale 70, the first OCS oil and gas lease sale in the St. George Basin and the southern Bering Sea, was held in April 1983. The oil industry submitted high bids of $472.3 million for 96 tracts totaling about 552,015 acres. Two additional sales are scheduled for the St. George Basin: Sale 89 in September 1985, and Sale 101 in December 1986.

The marginal probability of discovering commercial quantities of oil in the St. George Basin is 0.28, and hydrocarbon resource estimates for the Basin are 1.12

billion barrels (Bbls) of oil. Exploratory activity will follow each sale and last from five to ten years. Exploration plans have been filed to undertake a variety of activities during the summer of 1984. Cold Bay has been identified as the most likely air support service center for all activity in the St. George Basin. If a commercially viable oil find is made in the St. George Basin, potential transportation systems that would affect the Aleutians East CRSA include a pipeline directly to the south side of the Alaska Peninsula, or either offshore or onshore loading (at St. Paul or St. George) with transport of oil by tanker through Unimak Pass. One alternative being considered in the Sale 89 Environmental Impact Statement (the second St. George Basin sale) is the deletion of all tracts within a 50 mile radius of Unimak Pass.

North Aleutian Basin

The first sale in the North Aleutian Basin is scheduled for November 1985. There has been considerable controversy surrounding this sale, and delays are being sought by the State of Alaska as well as other concerned groups. The sale area originally covered approximately 32.5 million acres and contained 5,947 blocks that are located from 6 to 250 miles offshore. The conditional undiscovered recoverable estimate for oil is 450 Mbls with a 0.21 marginal probability of success. The apparent size of this potential field is small compared to other frontier areas (Lewbel 1983). If the sale is conducted as scheduled, exploratory activity is postulated to occur from 1986 through 1995, with development from 1992 to 1995. Production would begin in 1994 and peak in 1998. Applications to conduct pre-lease seismic tests in North Peninsula waters have been filed and activity in this area can be expected to increase. Oil is proposed to be transported from the field by a pipeline across the Alaska Peninsula (through the Port Moller-Balboa Bay transportation corridor) to a trans-shipment marine terminal located on Balboa Bay. The Secretary of the Interior has recently deleted inner Bristol Bay from the lease sale offering. In addition, one alternative being considered in the Sale 92 EIS is the deletion of 629 blocks off the Alaska Peninsula to protect the biological resources of the area.

Navarin Basin

Sale 83 occurred in April 1984 and Sale 107 is planned for 1986. While the Navarin Basin area is far offshore from the Aleutians East CRSA, Cold Bay may be used for air support services for exploration and development activities. In addition, transportation of oil from these fields would likely be by shuttle tankers through Unimak Pass to a VLCC terminal located along the South Peninsula.

Shumagin

The first sale scheduled for the Shumagin Planning Area is in June 1987. Area planning studies are just beginning and no specific information on potential oil and gas reserves or development scenarios is currently available.

Oil Spills

The Bureau of Land Management, Minerals Management Service (MMS) develops oil spill trajectory simulation models for each OCS oil and gas lease offering. Their models represent pathways and landfalls of hypothetical surface oilslicks. The models do not consider the movement of oil in water below the surface, the incorporation of oil into sediments, cleanup, dispersion, or weathering processes which would help determine the quantity and quality of oil that may potentially come ashore from a spill. The models consider where the hypothetical spill would be after three days (to represent diminished toxicity of the spill), 10 days (to allow for the deployment of cleanup equipment) and 30 days (to represent the end of the period where tracking is feasible). These models focus on crude oil spills occurring in a lease area. They do not consider potential spills of refined petroleum products (usually more toxic than crude oil) that may occur as such products are transported to offshore development sites.

Oil spill trajectory simulations undertaken for the North Aleutian Basin, St. George Basin, and Navarin Basin Environmental Impact Statements all show the possibility of oil coming ashore in the Aleutians East CRSA. Spills occurring in the North Aleutian Basin during the summer and fall (June through November) will likely be transported in an easterly direction toward Bristol Bay and could come ashore on the Alaska Peninsula within 30 days. Spills occurring during winter conditions will likely be transported toward the northwest into the Bering Sea and are less likely to come ashore in the Aleutians East CRSA (Thorsteinson 1984). Spills occurring in the southern St. George Basin will follow similar tracks (USDI 1981). Spills associated with oil development in the Navarin Basin (primarily from tanker accidents) have a greater than 10 percent probability of coming ashore on Unimak Island (USDI 1983).

Other oil discharges potentially resulting from OCS oil development and impacting the Aleutians East CRSA include spills from tanker traffic through Unimak Pass and chronic discharges from a marine terminal located on the south side of the Alaska Peninsula.

There are many uncertainties regarding the location and impacts of potential oil spills that could enter Aleutians East CRSA waters; consequently predicting impacts is extremely difficult and speculative. A detailed analysis of potential impacts from two hypothetical, fairly small oil spills originating in the North Aleutian Basin area was undertaken by the Outer Continental Shelf Environmental Assessment Program at a synthesis meeting in March of 1982; the reader is referred to that document for additional information.

Important resources along the North Peninsula and in Unimak Pass (the areas most likely affected by OCS related oil spills) are illustrated in Figure 3. Any particular OCS oil spill would not necessarily impact this entire area. The determination of which resources may be affected would be dependent on a number of factors including the location, timing, and size of the spill; the prevailing weather conditions; and the efficiency of clean-up operations.

Important biological populations present along the North Peninsula and Unimak Pass are shown in Figure 3. The lagoons and bays along the North Peninsula with their large and biologically significant eel grass beds, bird populations, marine mammal haul-outs, and fishery nursery areas are especially important and

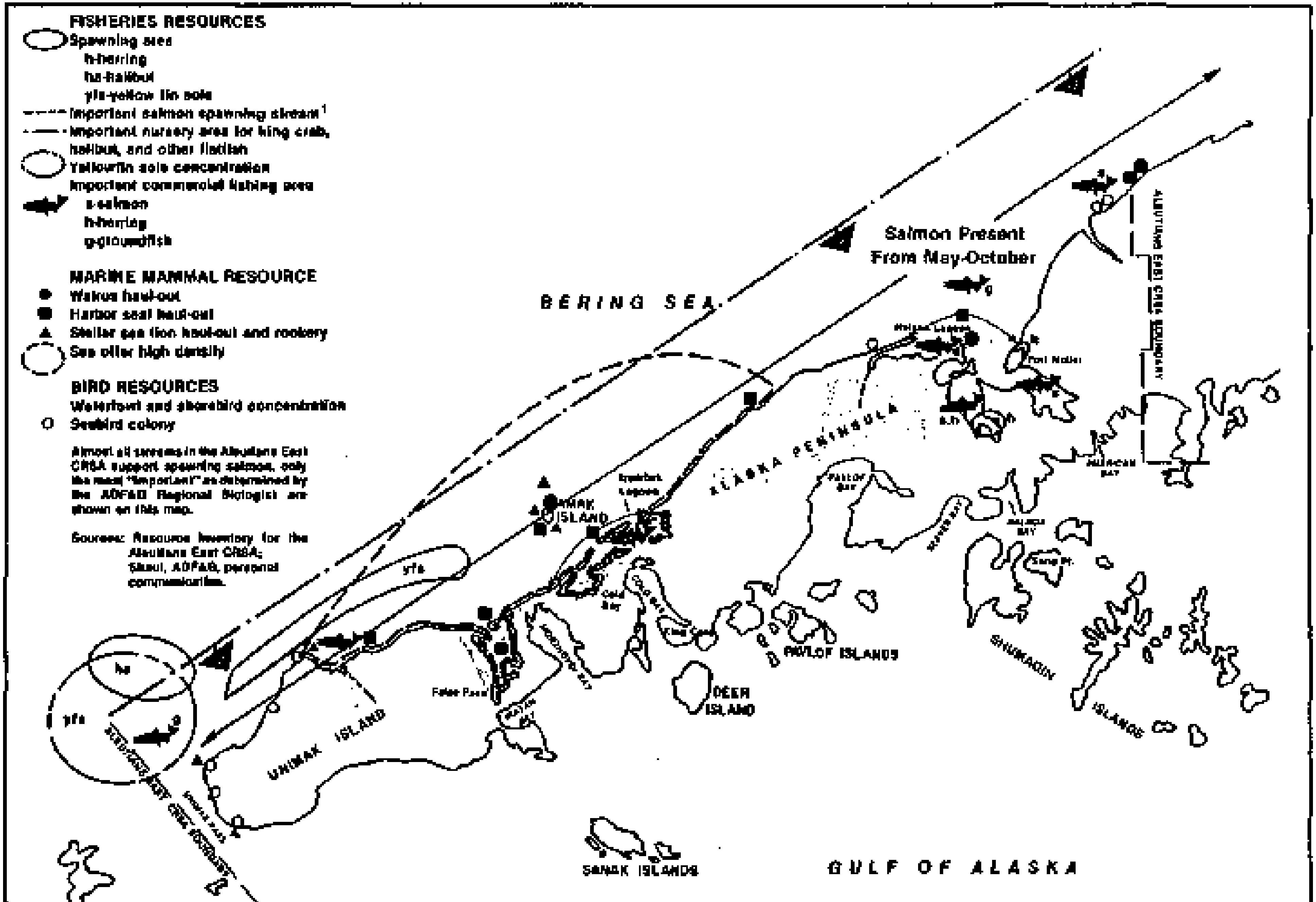


Figure 3 RESOURCES SENSITIVE TO OIL SPILLS RESULTING FROM BERING SEA OCS OIL AND GAS EXPLORATION AND DEVELOPMENT

sensitive habitat. They comprise a major portion of the total estuarine habitat of the Bering Sea.

Fisheries resources most sensitive to impacts from oil spills that enter waters north of the Aleutians East CRSA include red king crab, salmon, and herring. During the summer, red king crab larvae for an entire Bristol Bay year-class are found in the coastal waters off the North Peninsula. Herring, capelin and other ecologically important fish species spawn intertidally and subtidally along the North Peninsula. Salmon that spawn in Aleutians East CRSA streams as well as Bristol Bay salmon are present in North Peninsula waters both as seaward-migrating juveniles or returning adults from May until at least October. Juvenile salmon are most sensitive to impacts from oil spills. Juvenile sockeye salmon, and perhaps the other salmon species, migrate in a band whose center of abundance is 50 to 65 km offshore and may extend out as far as 165 km. Juvenile king salmon are probably most abundant in coastal waters off the North Peninsula in May and June, sockeye salmon in July and August, chum salmon in July through September, and pink and coho salmon in August and September. Of the adult salmon in a spill area, those with natal streams in that vicinity are most sensitive to oil spill impacts. Commercial fishing occurs in many locations along the North Peninsula. All these areas are sensitive to impact from oil spills (Thorsteinson 1984).

Birds most vulnerable to oiling are those which are gregarious, spend most of their time on the surface, and dive rather than fly when disturbed. These include murres, puffins, eiders, scoters, and oldsquaw. Large numbers of these species are found in the Aleutians East CRSA. Amak Island supports the largest seabird colony along the northern shore of the Aleutians East CRSA. Oiling of bays and lagoons could have significant impacts to shorebirds and waterfowl staging, molting or breeding in these habitats from spring to fall. Loss of aquatic vegetation from oil contamination in places such as Izembek and Nelson Lagoons could take years to replace, significantly impacting populations of dunlin, godwits, Steller's eider, king eider, Emperor geese, brant, and Taverner's geese (Thorsteinson 1984).

Sea otters and, to a lesser extent, fur seals are the marine mammal species most at risk from an oil spill in the waters of the Aleutians East CRSA. Amak Island and the nearby Sea Lion Rocks provide haul-out and breeding habitat for the largest concentration of sea lions in Bristol Bay. Walrus haul-out at Cape Seniavin, Nelson Lagoon, and Amak Island. Harbor seals are also abundant in bays and lagoons, particularly Bechevin Bay, Izembek Lagoon, and Nelson Lagoon/Port Moller (Thorsteinson 1984).

Unimak Pass is an area of extraordinary biological importance and is one of the major migration corridors for bird, mammal, and fish populations entering and leaving the Bering Sea. Major portions of populations of humpback, fin, and gray whales and northern fur seals are regular seasonal migrants through the pass during spring and fall; essentially the entire population of gray whales travels through Unimak Pass in the spring and fall. Immense flocks of shearwaters feed in Unimak Pass and large colonies of tufted puffins nest on nearby islands. Large numbers of adult salmon returning to natal streams in the Aleutians East CRSA, Bristol Bay, and other Bering Sea locations also use Unimak Pass in the spring and summer (Thorsteinson 1984).

2.1.2 STATE SUBMERGED LANDS, TIDELANDS, AND ONSHORE OIL AND GAS DEVELOPMENT

The oil and gas industry has been interested in the Alaska Peninsula, including the Aleutians East CRSA, since the late 1800s. Exploration took place in this area between 1898 to 1910 and again in the 1920s and 1930s. Indications are that both oil and gas, particularly the latter, are present along the Peninsula. Over the last 20 years, the area has been explored by several oil companies including Gulf Oil and Amoco Oil. Wells have been drilled near Port Moller, Herendeen Bay, and the Sandy River. The State Bristol Bay Area Plan shows high oil and gas potential for the area from Port Moller to Cold Bay and moderate potential from Cold Bay to Unimak Island.

According to the Five Year Oil and Gas Leasing Program presented to the Alaska Legislature in January 1984, oil and gas leasing is proposed for September 1988 for uplands on the Alaska Peninsula from north of Port Heiden to the Izembek National Wildlife Refuge. Approximately one million acres are to be included in the sale. Petroleum potential in the area is considered low to moderate, as determined by a state-wide scale.

Within the Aleutians East CRSA, petroleum development activities could have effects on the communities of Cold Bay and Nelson Lagoon. The area proposed for the sale encompasses the important bird use areas around Port Moller and Herendeen Bays. Shorebirds and waterfowl use this area extensively. Caribou migration and calving areas and salmon spawning streams along the north side of the Alaska Peninsula are also included in the proposed sale area. Depending upon the types of development which may occur and their locations, there could be significant impacts upon the biota of the Aleutians East CRSA.

2.1.3. Mining

There is currently no large-scale mining activity in the Aleutians East CRSA. A small suction dredge is presently operating in marine waters near Sand Point. A single area of State of Alaska mining claims is located between Herendeen Bay and Port Moller, and a State of Alaska coal prospecting permit application covers a large area west of Herendeen Bay and northeast of Canoe Bay. Coal is also found on Unga Island. Numerous mineral occurrences are present with the CRSA, and the Region is considered to be highly prospective for mineral deposits of economic merit.

The Apollo-Sitka gold/silver mine on Unga Island represents the only significant mineral development in the Aleutians East CRSA to date (Figure 4). From 1892 to 1912, the mine is reported to have produced 107,900 ounces of gold averaging 0.22 oz/ton of ore. The mine is presently owned by Alaska Apollo Gold Mines Ltd., headquartered in Vancouver, British Columbia. Recent activity in the mine

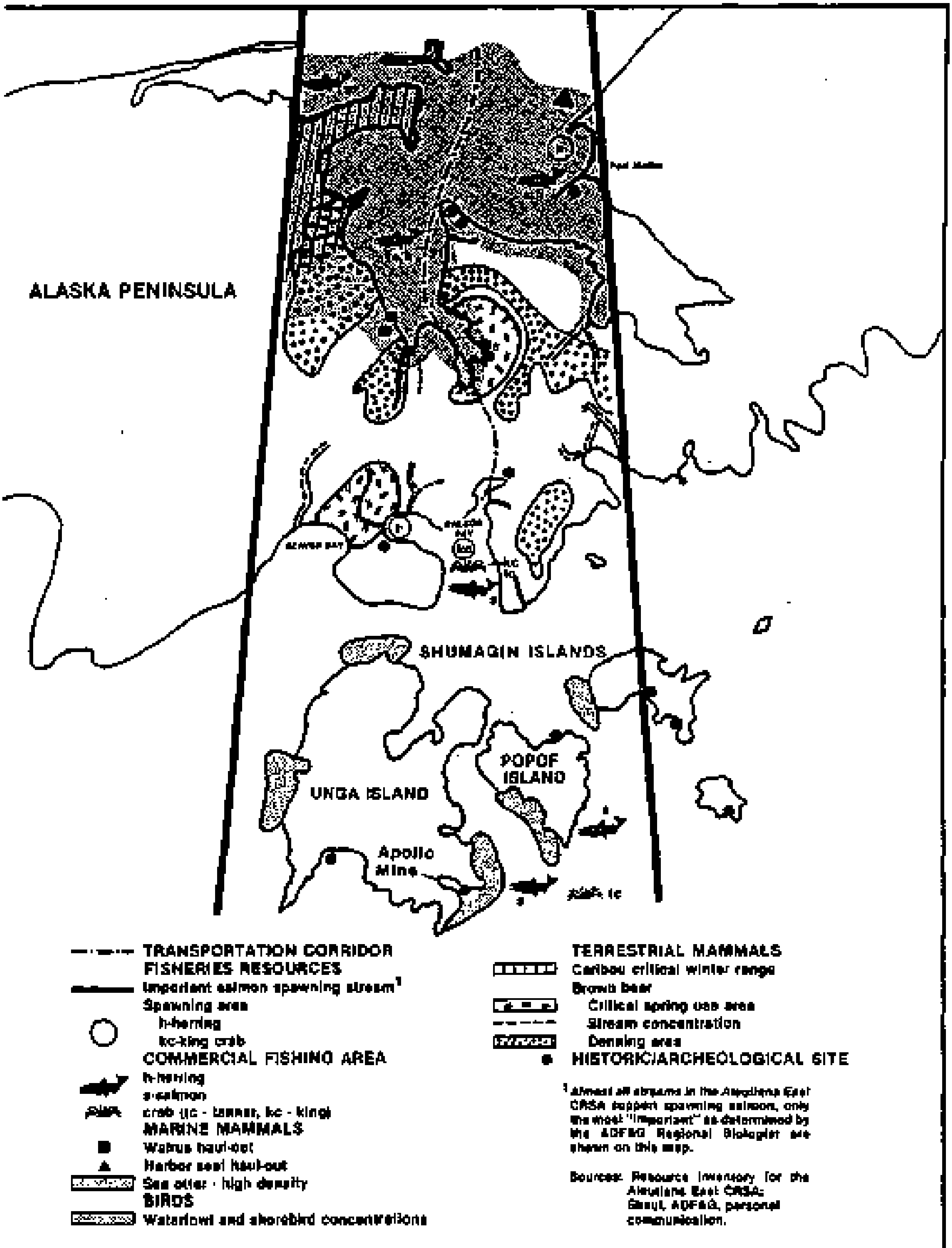


Figure 4 BALBOA BAY-PORT MOLLER TRANSPORTATION CORRIDOR AND APOLLO MINE

workings and other claims indicates that significant additional tonnage of similar grade may be present. The Appolio mine may recommence operations in the near future. Long-range development plans include a road link between Delarof Bay and deep water on Beralof Bay, conversion of a beached tanker to a processing facility, and construction of an aircraft runway at the head of Beralof Bay.

Resource Associates of Alaska, Inc., Freeport Exporation Company, UNC Teton, and Houston Oil and Minerals have conducted exploration programs for hard rock minerals on Aleut Corporation lands on the Alaska Peninsula and Shumagin Islands. This work has identified numerous promising prospects on Unga Island, as well as prospects on the Alaska Peninsula such as Pyramid Mountain, Canoe Bay, Mud Bay, and Walrus Peak.

Future mineral development in the Region will depend on additional exploration work being done to locate and evaluate potential mineral deposits as well as the world economic climate. The Aleutian weather and access to water, however, are significant benefits to mineral development in the Aleutians East CRSA.

2.1.4 MARINE TRANSPORTATION

2.1.4.1 Pipelines

Submarine pipelines may be used to transport oil and/or natural gas from offshore production platforms to onshore processing, storage, and loading facilities. While there are no pipelines currently scheduled for construction within the Aleutians East CRSA, offshore oil production in either the St. George Basin or the North Aleutian Basin could result in a submarine oil pipeline being constructed from the offshore oil field to the north side of the Alaska Peninsula. The pipeline would then continue onshore to a south Peninsula marine terminal. The specific routing of a submarine pipeline would depend on the location of the offshore production platforms, bottom topography and surface sediments, and the location of a suitable onshore site for pipeline alignment. The two most likely entry points are Izembek Lagoon and Port Moller-Herendeen Bay (see Section 2.1.5).

2.1.4.2 Shipping

Unimak Pass, which forms the western border of the Aleutians East CRSA, is the major shipping lane between the Bering Sea and the North Pacific Ocean. Navigation through Unimak Pass and throughout the Aleutians East CRSA region is usually complicated by storms and heavy fog. Superstructure icing is also a problem. Current vessel use of Unimak Pass is difficult to estimate; the most recent estimate places the traffic between 2,400 and 6,500 vessel trips per year. Eighty to eighty-five percent of this traffic is thought to be fishing vessel traffic; the remainder is composed of commercial and natural resource (primarily fuel) shipping. Both foreign and domestic vessels use Unimak Pass. There are no traffic separation systems currently in place in Unimak Pass nor are any planned for the foreseeable future. Vessel traffic is significant in other areas of the Aleutians East CRSA as well. Barges which transport fuel and supplies to Aleutians East CRSA towns and villages, and both foreign and domestic fishing vessels are present in the waters of the Region year-round.

Significant increases in oil tanker traffic through Unimak Pass will result if oil is discovered in any of the Bering Sea OCS lease sale areas. If a marine terminal is built on the south side of the Alaska Peninsula, VLCC will begin to frequent the Region's waters. The Coast Guard is currently undertaking a study of the need for a traffic separation system in Unimak Pass (Federal Register 1984). Important resources in the Unimak Pass vicinity are shown in Figure 3.

A recent U.S. Army Corps of Engineers reconnaissance study of navigation improvements required to support an expanded bottomfish industry recommended channel improvements to False Pass that would significantly cut transit time to the Bering Sea. The Corps proposed deepening and widening the channel from Traders Head through Bechevin Bay into the Bering Sea. Channel depths are currently 10 to 12 feet at mean low water. The proposed project considers deepening the channel to 20 feet at mean low water and would require dredging significant amounts of sand. It is not known how frequently maintenance dredging would be required to maintain channel depth. While the Corps is continuing to study this project, there are no current plans or funds to implement it.

2.1.4.3 Ports and Harbors

Port and harbor expansion is a priority improvement for all Aleutians East CRSA communities. In addition, new port development within the region has been discussed in relation to a variety of OCS oil and gas development scenarios.

Cold Bay has been cited as a possible stop for a proposed cargo ferry to be operated by the State of Alaska. A preliminary study recommended a site for the new port 700 feet south of the existing fuel pier. The face of the pier would be T-shaped, approximately 60 feet wide by 140 feet long. The dock would extend about 1,500 feet from shore. Dredging would be required to obtain adequate channel depth and provide fill for a shore-side storage area. Currently, there are no plans to undertake this project.

Inadequate harbor facilities are a major constraint to development in Sand Point. During the last several years, Sand Point considered several alternatives for significantly expanding their harbor facilities. The U.S. Army Corps of Engineers completed a reconnaissance report for harbor expansion in Sand Point in 1983. The report recommended development of a second harbor adjacent to Humbolt Harbor to service the mostly non-resident groundfish fishing fleet. The proposed project would require only limited dredging; the major activity would be the construction of a breakwater. While work is continuing on detailed project plans, no funds have been allocated for harbor construction. Humbolt Harbor is scheduled for a harbor condition survey in 1984 and will probably receive maintenance dredging in 1986.

King Cove also has insufficient harbor space for its fishing fleet and there are currently over 60 vessels between 75 and 120 feet in length on a waiting list for permanent berths. In 1981, the State completed a preliminary feasibility study for a new dock capable of handling ocean-going freighters, the State ferry, and additional fishing boats. The findings were favorable and the City is currently seeking state funds for the final engineering and construction of the public dock. The U.S. Army Corps of Engineers is also studying the feasibility of harbor expansion in King Cove. Such expansion would require significant dredging. The existing harbor is scheduled for a harbor condition study and maintenance dredging in 1984.

False Pass is attempting to obtain state funds for a small boat harbor. This project is, however, in a very preliminary planning phase.

A reconnaissance study of a small boat pullout facility in Nelson Lagoon will be undertaken in 1984.

If commercial quantities of oil are discovered in the vicinity of the Aleutians East CRSA, the need for a major marine terminal on the south side of the Alaska Peninsula for the trans-shipment of oil produced in the Bering Sea has been identified in development scenarios developed by the Minerals Management Service for the Navarin, St. George, and North Aleutian Basins. While initial studies identified Morzhovoi Bay, Cold Bay, Pavlof Bay, Balboa Bay, and Stepovak Bay as potential sites, most recent discussions focus on Balboa Bay. The terminal would include port facilities for both incoming shuttle tankers and for VLCC or supertankers that would carry the crude oil to refineries located in the continental United States. Balboa Bay supports a spawning herring population in Left Hand Bay and red king crab spawn in the Bay's deeper water. Streams entering Left Hand Bay support critically important pink, chum, and coho salmon spawning populations. Commercial fishing for salmon, king crab, and tanner crab also occurs in Balboa Bay (Figure 4).

2.1.5 ONSHORE TRANSPORTATION

Within the communities of Sand Point and King Cove, there are numerous plans to build roads, mainly in connection with construction of residential subdivisions and/or industrial facilities. King Cove anticipates residential and commercial expansion into the Ram Creek Subdivision, necessitating construction of several roads in the area. These proposed roads would entail at least ten crossings of Ram Creek and its tributaries. Further residential development is planned for an area across the lagoon north of the existing town. This will require a road (West Lagoon Road) to be built along King Cove Lagoon to the subdivision.

Sand Point envisions a road extention along Humbolt Harbor south of town in the event that a boat harbor is built there. East of town, a residential subdivision is planned as is an extension of Red Cove Road.

At the present time, there are no roads, pipelines, transmission lines, or railroads between communities in the Aleutians East CRSA. Most communities have, however, some facility usable by aircraft. Future growth of resource-related industries may stimulate construction of one or more onshore transportation elements.

The draft Bristol Bay Cooperative Management Plan considered several preferred regional transportation corridors for the Aleutians East CRSA: Ikatan to False Pass, Bering Sea to Morzhovoi Bay, Cold Bay to King Cove, and Port Moller to Balboa Bay. These areas would be the preferred routing for any future roads, pipelines, or transmission lines. The proposed road between King Cove and Cold Bay would be routed along the east side of Cold Bay and through the Izembek National Wildlife Refuge. The transportation corridor from Port Moller to Balboa Bay may be used if there is a need to transport oil or gas by pipeline from fields in the Bering Sea to a port on the Gulf of Alaska. It is not anticipated that the other two routes outlined will be developed in the near future.

If the Cold Bay/King Cove road or Port Moller/Balboa Bay transportation corridor is constructed, they will traverse areas used by waterfowl, caribou, moose, and bears. Salmon streams will be crossed by roads and pipelines. Caribou migration routes along the Peninsula may be bisected and sensitive waterfowl use areas will be traversed. Important historic and archeological sites are also located along the corridor. In addition, both routes pass through areas currently used for subsistence, recreation, sport hunting, and fishing.

There are no new airports planned for the Aleutians East CRSA, although improvements are outlined for currently existing facilities at Sand Point, King Cove, Cold Bay, and False Pass. A transportation needs assessment done by ADOT/PF in 1982 recommended several repairs and improvements for aircraft facilities within the Aleutians East CRSA, including:

- Realigning and extending the runway at Sand Point and constructing an apron for aviation related services;
- Resurfacing Cold Bay runway and extending the crosswind runway;
- Constructing a new terminal building and expanding the runway aprons at Cold Bay; and
- Rebuilding the runway at False Pass to restore it to its original length before it was bisected by a stream channel.

2.1.6 ALTERNATIVE ENERGY

In 1980-1982, the Alaska Power Authority conducted reconnaissance studies in the Aleutians East area to determine the need for power generation. As a result of that study, construction of a hydroelectric project was recommended on Delta Creek near King Cove. No other hydroelectric developments are currently proposed for the Aleutians East CRSA. Delta Creek is an anadromous fish stream and contains spawning populations of silver and chum salmon.

The Delta Creek project is proposed as a run-of-river concrete diversion dam with a 329 kilowatt capacity. The site would be located approximately 10 miles from King Cove, 4.7 miles from the mouth of the creek. Construction of about 5 miles of new road would be needed to reach the site. It is proposed to build 3,500 feet of 30 inch diameter pipe for a penstock. This would achieve a 300 foot drop in "head", or elevation, to the power house. Five to six miles of transmission line will be needed from the powerhouse to the village. There will be no reservoir, which limits the plant's ability to function during dry periods. It is anticipated that the project will be low maintenance and could operate for 30 to 50 years.

2.1.7 COMMERCIAL FISHERIES DEVELOPMENT IN THE ALEUTIANS EAST CRSA

The commercial fishing industry has dominated and will undoubtedly continue to dominate the regional economy of the Aleutians East CRSA for the foreseeable future. However, this industry is extremely dynamic - the species of importance, the participants, the economics, and the technology all continually change - and it appears that the fishing industry in the Aleutians East CRSA is currently entering a period of transition. While there are no specific projects currently planned that will radically alter the Aleutians East CRSA fishing industry, changes in resource availability may propel the industry in new directions.

The Aleutians East CRSA is geographically positioned in an area of abundant and commercially important fish and shellfish species. For the last ten years, salmon, king crab, and tanner crab have formed the resource base for the region's fishing economy. Future expansion of the fishing industry based on these traditional species is, however, unlikely.

As documented in the Volume II, salmon populations are currently harvested at near maximum allowable levels. Like all natural populations, salmon undergo natural changes in population size. Populations have been at record highs during the last several years and salmon abundance is not expected to exhibit significant natural increases in the future. If the Russell Creek Hatchery facility at Cold Bay becomes fully operational, up to 750,000 additional adult chum salmon will be made available to the fishery each year. While this represents a significant number of additional chums (50 percent of the recent 5-year average South Peninsula chum salmon harvest), the increase can easily be harvested by the existing fleet and processed by the existing processors. Hence no new processing facilities are envisioned to handle the hatchery's fish. The hatchery will be perhaps most important to the region in helping to stabilize chum salmon catches.

Entry into the salmon fishery is limited to approximately 400 permit holders. Since numerous fishermen hold more than one permit, it is quite possible that through permit sales and transfers, the number of fishermen participating in the Alaska Peninsula salmon fishery will increase. Increased effort has occurred in this fishery over the last several years and this trend may continue. Given the limited salmon resource, expanding effort can be expected to make the fishery more competitive, resulting in shorter fishing periods and increased demands for harbor space.

The majority of salmon limited entry permits in Area M, the area that encompasses the Aleutians East CRSA, are owned by local residents. Permit sales and transfers to non-residents were few between 1975 and 1979 with only 8 permits sold to non-residents. Between 1979 and 1981, 33 permits were sold to non-residents of the Aleutians East CRSA, primarily out-of-State fishermen. If this trend continues, it could have serious impacts on the local economy.

Both king and tanner crab populations in the vicinity of the Aleutians East CRSA are at low levels. King crab seasons were cancelled in 1983 in both the Bristol Bay and South Peninsula Districts, and there are few positive signs to indicate that the stocks will recover quickly. Tanner crab populations are also low, although it appears that a modest fishery will continue for the foreseeable future. The reduction of crab stocks resulted in 1983-84 winter closures of the Region's two major fish processing plants. Given these declines, fishermen and processors are looking for alternative fisheries to supplement salmon fishing. The development of additional fisheries and fish processing opportunities in the Aleutians East CRSA Region is overwhelmingly favored by the Region's residents (Aleutians East CRSA 1983).

Other species presently or historically available for harvest from Aleutians East CRSA waters include herring, capelin, halibut, Dungeness crab, shrimp, clams, and groundfish. None of these species currently make significant contributions to the Region's fishing economy. As fishermen and processors look to expand their opportunities, they must look to those species that are either not fully utilized, or as is more frequently the case, utilized by fishermen and processors from outside the Aleutians East CRSA.

Over the next several years, the herring, halibut and Dungeness crab fisheries are likely to increase in importance to Aleutians East CRSA fishermen and processors. Increased harvesting and processing of these species would result in few changes to either the Region's fishing fleet or processing facilities; rather, they would allow for the use of existing equipment for longer time periods and increase the economic efficiency of the industry.

Herring fishing is carried out on both the north and south sides of the Peninsula and a number of Aleutians East CRSA residents fish in the Togiak herring fishery. Stock sizes in Aleutians East CRSA waters are poorly known so that it is difficult to predict the eventual magnitude of either fishery. Record catches to date have been 787 tons from South Peninsula waters and 838 tons from North Peninsula waters. While it is likely that the North Peninsula fishery will continue as a spring fishery for roe herring, the future allocations between a winter food/bait fishery and a spring roe herring fishery in South Peninsula waters are uncertain. Local participation in the harvesting sector has been limited but is expanding, and local boats are suitable for harvesting herring. Herring processing has occurred in both Sand Point, King Cove, and Port Moller; all plants could easily handle and produce more processed herring.

Capelin, which are available for harvest just after the spring herring season, have not yet been commercially exploited in Aleutians East CRSA waters. Small quantities have been experimentally harvested both in Aleutians East and Bristol Bay waters, but the potential of this fishery remains unknown. If it does develop, it is likely to be a seine fishery and ancillary to the spring herring fishery (Hale 1983).

Halibut fishing is carried out in the Gulf of Alaska to the south of the Aleutians East CRSA. Bering Sea waters to the north are classified as a halibut nursery area and are closed to halibut fishing. In the early 1960s halibut catches in the northern Gulf were between 30 and 40 million pounds annually. Catches dropped dramatically during the 1970s. Stocks appear to be recovering somewhat and the 1982 catch was over 18 million pounds with about one million pounds coming from the waters adjacent to the Aleutians East CRSA. Most of this catch was taken by large halibut boats from outside the Region. Only limited numbers of local fishermen participate in the halibut fishery because recent seasons have been very short and fishing periods have conflicted with the salmon season. Local participation would be expected to increase significantly if the halibut fishing season was longer or was at a different time. Both the Peter Pan King Cove processing plant and Aleutian Cold Storage in Sand Point aggressively bought halibut in 1982 and 1983, and both plants would like to increase their production in the future.

The Dungeness crab fishery is currently expanding in the Aleutians East CRSA, with catches increasing from almost zero in 1981 to over 800,000 pounds in the 1982-83 season, even higher catches are anticipated for the 1983-84 season. The potential for expansion of this fishery is not known as there is almost no information available on the Alaska Peninsula's Dungeness crab population. The record harvest was just over 1.2 million pounds in 1968. Local participation in this fishery is expanding and this trend is expected to continue. The vessels used by Aleutians East CRSA residents for tanner and king crab are suitable for Dungeness fishing and local processors are currently processing this species. There appear to be no real impediments to full development of commercial fishing for this species.

Shrimp have not been harvested commercially in Aleutians East CRSA waters since 1979 because of drastic declines of this resource. During the 1970s shrimp catches peaked with a record harvest of almost 50 million pounds taken in 1977. Much of the harvest was processed at the Peter Pan processing facility at Squaw Harbor (currently closed). Few Aleutians East CRSA residents participated in this fishery which was dominated by Kodiak trawlers. If shrimp populations recover to commercially exploitable levels in Aleutians East CRSA waters, it is likely that local involvement will be much more significant.

A major Bering Sea clam resource northeast of Port Moller remains unexploited and there are no current plans to harvest this resource. If it is developed, it is unlikely that local fishermen will be involved, since larger boats with more horsepower than those currently used by Aleutians East CRSA fishermen are needed to pull the large dredges used to harvest clams.

Groundfish Development

The potential for the Aleutians East CRSA fishing industry to participate in the developing domestic groundfish fishery is of great interest to the residents of the region. A recent survey carried out by the Aleutians East CRSA found that 74 percent of the area's residents favored the location of an onshore groundfish processing plant in the region (Aleutians East CRSA 1983). Despite interest by local processors, there are no specific plans to either locate a new groundfish processing plant in the Aleutians East CRSA or to expand existing plants to include groundfish processing. To date there has been very limited local participation in harvesting groundfish.

The domestic groundfish industry in the Bering Sea and Gulf of Alaska has consisted almost exclusively of joint-ventures (a domestic harvester boat delivering its catch at sea to a foreign processing vessel) and large domestic factory trawlers. Onshore processing has been attempted in several locations, including limited salt cod operations in Sand Point and Squaw Harbor, but with little economic success. Local vessels have not participated in joint ventures primarily because the local fishing fleet is almost entirely composed of vessels less than 58 feet in length (the maximum vessel size allowed to fish in the salmon seine fishery). Such vessels are too small to economically stay at sea and trawl in a typical joint venture where high volume is the key to profitability. A 58-foot vessel can pull only a relatively small trawl and there are many days when the severe weather would preclude them from operating. In addition, local vessels can carry only limited quantites of fuel, water, and supplies.

There are significant impediments to the development of a substantial groundfish industry in the Aleutians East CRSA including the unproven profitability of onshore processing plants, the size of vessels in the local fleet, and the projected decrease in the Region's cod population (the most valuable groundfish species) during the later half of the 1980s (Wespestad 1981). Recent studies of potential groundfish development opportunities for the Aleutians East CRSA as a whole and for Sand Point are not optimistic about significant development in the near future. While both of the major processors in the region are considering expansion of production facilities to include groundfish, neither have made any definite plans to do so. The Peter Pan facility in King Cove has, however, contracted two local vessels to longline cod this year on an experimental basis. If this effort is successful, additional groundfish developments may take place (Gronholdt, personal communication).

Combs, Inc. (1980) evaluated potential impediments to onshore groundfish developments and concluded that both False Pass and Nelson Lagoon have several critical impediments to development including harbor potential, transportation links, and, in the case of Nelson Lagoon, lack of access to the resource. Both King Cove and Sand Point were better situated for potential development, although both sites had moderate impediments to development including land availability, climate, and transportation links. Nebesky et al. (1983) made a series of projections for groundfish development in the Aleutians East CRSA. Under a low-level growth scenario, the activity associated with groundfish development is anticipated to be negligible. Under an intense development scenario, a level of groundfish development consistent with that forecast by the

R&M/TAMS (1981) study is assumed. By 1992 this projection anticipates domestic groundfish harvests to increase to 10,000 mt per year, utilizing six 90-foot vessels and an onshore processing plant in Sand Point. Harvest related employment would be 24 jobs with an additional 25 onshore processing plant worker jobs. The annual value of the catch would be $8 million, with another $8 million as a layover station for vessel maintenance, storage, and supply for about 50 non-resident vessels per year. This could result in an additional 15 jobs.

2.1.8 RECREATION AND TOURISM

It is not expected that current usage of recreation resources will change much in the near future in the Aleutians East CRSA unless oil and gas development, mining, or changes in the commercial fishing industry cause increases in the population and infrastructure of the area. Once access and facilities are established, recreational exploitation will increase. Sport harvest and recreational activities will require many of the same facilities, i.e., lodges, campgrounds, hiking trails, etc. The proposed BBCMP considers the area between Port Moller and Izembek Lagoon as having high recreational value. The same is true of Izembek to False Pass and Unimak Island. It is suggested by the BBCMP that these areas be managed for fish and wildlife resources and possibly for wilderness values, where so designated by Congress. There are, however, no planned developments related to recreation and tourism in the Aleutians East CRSA at this time.

2.1.9 SPORT FISHING AND HUNTING

There are no planned developments related to sport fishing and hunting in the Aleutians East CRSA at this time.

2.1.10 LAND DISPOSAL

Land disposals identified in Figure 1 are those considered in the draft Bristol Bay Cooperative Management Plan. In this scenario community expansion on Native, state, private, and municipal lands around existing communities is allowed. If a land exchange between the U.S. Fish and Wildlife Service and the State of Alaska involving about 1,000 acres around Cold Bay is completed, this land would be offered for sale for community expansion. Three other State land disposals are proposed: 1,000 acres between three sites at the Port Moller North area, around American Bay, and around Dorenoi Bay. These State sales would be primarily for remote, low density settlement.

SECTION 3.0: REFERENCES

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